# POWER

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## Disarmament

THE outstanding figures in the World's history have been the organizers and leaders of armed hordes seeking power and plunder through the subjugation and looting of other people. Nations have waxed great, not by the arts of peace and industry, but by force of arms.

If any nation did behave itself and avoid a fight long enough to create some wealth, it became the object of attack and conquest by a covetous neighbor.

From Alexander the Great to the Bowery Thug, the eternal menace to peaceful security is the man who wants to enrich himself or his nation by robbing others instead of creating on his own account.

Joshua descended upon the peaceful land of Canaan and put it to the sword because he thought his people ought to have it.

Germany committed a daylight robbery of France, with the World looking on, in 1870, and shook the foundations of civilization recently in an attempt to grab for herself a place in the sun.

Every nation that has anything in the house worth stealing has to carry a pistol on its hip and mount a machine gun at the front door.

It is time for some organization of the moral forces and peace-loving nations of the world against national banditry and predatory militarism.

It is time for removing the halos and heroics from the sword-swingers and swashbucklers of history and writing them for the pests that they were.

It is time to laugh jingoism off the stage and to cease making patriotism a cloak for participatory plunder.

There ought to be a Sullivan law for the nations.

No nation ought to be obliged to spend half its income in keeping ready to be attacked.

The business of the world is disorganized by the debasement of European currency. To meet their deficits the governments are printing marks and francs and kronen and lire; and the more they print the less they are worth. When the people refuse to accept them, there is nothing left but barter. Modern commerce cannot travel at the barter pace.

The present disorganization of exchange is one of the causes of our own hard times.

The sum of the deficits of the budgets of Europe is just about equal to the cost of maintaining their armed forces.

It ought to be made safe for them to disarm.

The outraged sensibilities of the world ought to be so aroused by this time that it would be just as unthinkable for one nation to make an unprovoked attack upon another as for a tough to assault a schoolgirl on Broadway.

# Sawdust Burned with Aid of Steam Jets

## Large Industrial Plant Burns Both Sawdust and Coal Under Same Boilers—Automatic Control Speeds Up Stokers When Sawdust Supply Becomes Low

ONE of the largest jobs in the country during 1920 was the erection of the Fisher Body Ohio Company's plant at Cleveland, built for the purpose of constructing automobile bodies. The manufacturing plant consists of a six-story reinforced concrete body building having a total frontage of approximately 2,400 feet.

The size of the plant is such that there is a large demand for power and lighting. The dry kilns will require large quantities of medium-pressure steam, compressed air will be needed by the body-building and paint shop, and another service of considerable magnitude will be the heating load. Because of distances involved and the desire for uniform temperatures, a hot-water system of forced circulation was installed. The exhaust steam for the air compressors, boiler-feed and circulating pumps is to be utilized in the heaters, and when necessary, this supply will be supplemented by live steam from the boilers through reducing valves.

At the present, electrical energy is purchased, although it is the ultimate intention of the company to generate its own current for light and power. All the other services enumerated are supplied from a power plant erected near the center of the site. The building, which is 115 ft. long by 96 ft. wide, contains five water-tube boilers set singly and arranged for both coal and sawdust burning, as shown in Fig. 1. Each boiler contains 5,500 sq.ft. of steam-making surface and operates at a pressure of 175 lb. gage. Superheaters have not been installed. The boilers are equipped with underfeed stokers for burning the coal, and a semi-dutch oven gives the large volume needed to burn the sawdust. With the bottom of the front-tube header 13 ft. 6 in. from the floor line, a furnace volume of 1,430 cu.ft. is obtained. The boiler is baffled vertically for three passes, and back of the bridge wall under the second and third passes, a secondary combustion chamber of approximately 1,300 cu.ft. has been provided, the purpose being to reduce the velocity of the gases and in this space consume any unburned sawdust or shavings that may be carried over from the main combustion chamber. From the third pass the gases rise vertically around the boiler drum into a tapered smoke flue, having a straight run into a radial-brick stack 11 ft. in diameter at the top and 225 ft. high above the grate.

Sawdust is to be the primary fuel and will be burned as long as it lasts. To fill in the intervals and supplement the wood fuel, a live bed of coals will be main-

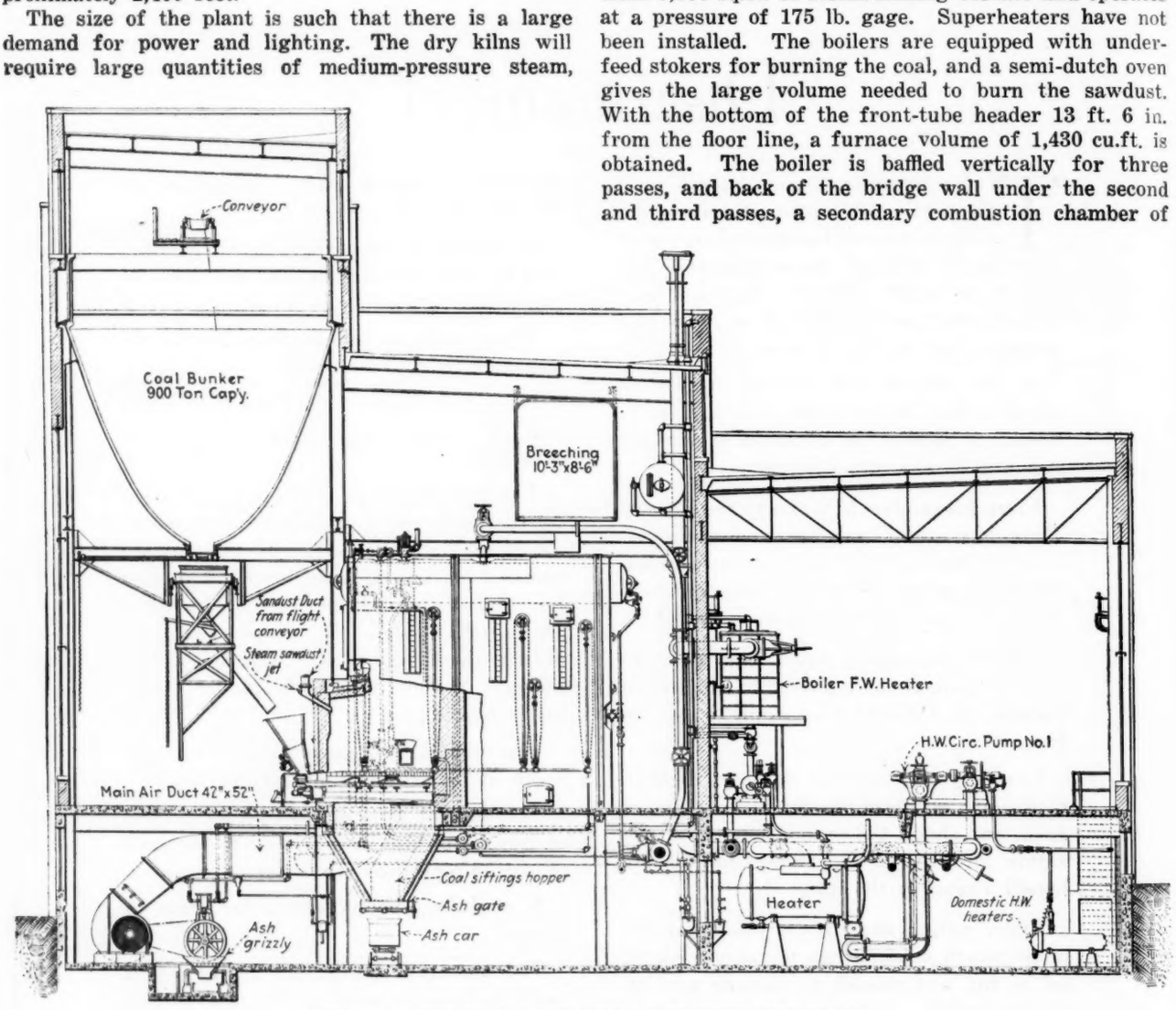


FIG. 1. SECTIONAL ELEVATION THROUGH THE PLANT

tained in the underfeed stoker. Just as soon as the boiler pressure drops, an automatic regulator will speed up the stoker rams and the vertical engine driving the forced-draft fan. This automatic control is shown in Fig. 2. It consists of a master pressure regulator connected by chains to a regulating valve in the live steam line to the stoker ram and to a balanced valve in the steam supply to the fan engine.

From the mill building sawdust is delivered to the plant by a cyclone system discharging into a separator and thence into an overhead bunker. To eliminate arching of the material, the bottom of the bunker is of large area and is equipped with eight drag chains provided with fingers, which continually pass through the sawdust and scrape it out into a flight conveyor. The sawdust bunker is located at the end of the coal bunker, and the flight conveyor extends across the furnace fronts. From the upper and lower runs of this conveyor three spouts are carried out to each furnace. The sawdust drops into these spouts and is ejected into the furnace by means of $\frac{3}{8}$-in. steam jets. Any tailings carried over on the flight conveyor that are not delivered to the boilers, are discharged into the boot of a bucket elevator and returned to the sawdust bunker. The arrangement is shown in Fig. 3.

Owing to the recent depression in the industry there has been little opportunity to try out this combination burning of sawdust and coal. The latter fuel has been used mostly, but in one boiler upon occasion the two fuels have been burned with excellent results.

To serve the stoker installations, two forced-draft fans, each having a capacity of 41,000 cu.ft. per min. against a static pressure of $5\frac{1}{2}$ in., are connected to a common flue with dampered outlets to the windboxes of the stokers and a damper in each fan discharge. Each fan is geared to a 7 x 9-in. vertical engine under the control of the pressure regulator previously mentioned.

Coal for the plant is delivered from railway cars into a track hopper and passes into a pan conveyor which carries it to the coal crusher, the latter discharging into a continuous bucket conveyor which delivers the coal to the overhead bunker. From the bunker a two-ton motor-driven weigh larry receives the coal and delivers it to the stoker hoppers.

From the ash hopper under each stoker, the ashes are dumped directly into industrial cars, which are emptied through an ash grizzly into the continuous bucket conveyor. The conveyor delivers the ashes to an overhead bunker located over the railway track at the end of the boiler room opposite to that in which the sawdust bunker is placed. The ashes are discharged to railway

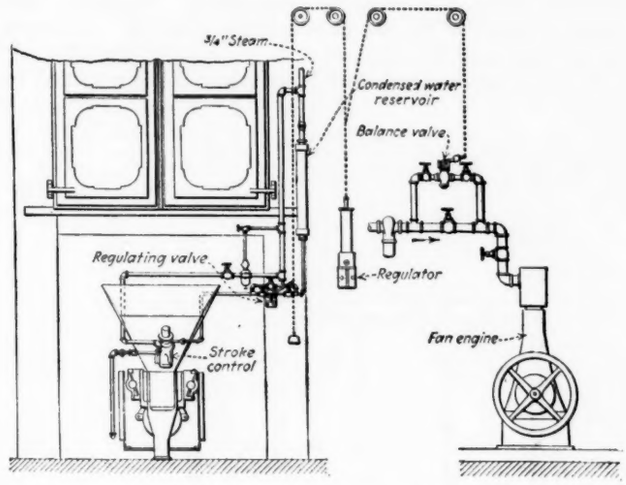


FIG. 2. STOKER- AND FAN-ENGINE REGULATION

cars through a spout suspended from a four-wheeled truck, which, from the boiler-room floor, can be moved by means of chains to the side of the track out of the way of the locomotive pulling the cars designated to receive the ash.

Returns from the steam lines in the mill building and the dry kilns come back to a receiver tank in the boiler-room basement. The condensation from the hot-water heaters is also collected here. This supply of boiler-feed water is raised to an overhead tank in the boiler room, which discharges by gravity under float control to an open feed-water heater. One turbine and

PRINCIPAL EQUIPMENT OF FISHER BODY OHIO PLANT

| No. | Equipment | Kind | Size | Use | Operating Conditions | Maker |
|---|---|---|---|---|---|---|
| 5 | Boilers | Heine type water tube | 5,600 sq.ft. | Generate steam | 175-lb. press., no superheat | Union Iron Works. |
| 5 | Stokers | Type C underfeed | 97.5 sq.ft | Serve boilers | Steam-actuated | Combustion Engineering Corp. |
| 2 | Fans | | 41,000 cu.ft | Forced draft | Driven by 7x9-in. Troy engine | Bailey |
| 1 | Conveyor | Apron | 30-in. wide | Coal track hopper to crusher | Driven by 7½-hp. Allis-Chalmers ind. motors | Stephens-Adamson |
| 1 | Crusher | Two-roll | 50 tons per hour | Crush coal | Dr. by 25-hp. Allis-Chalmers ind. motor | Stephens-Adamson |
| 1 | Conveyor | Pivoted-bucket | 18x24 in | Coal from crusher to bunker | Dr. by 15-hp. Allis-Chalmers ind. motor | Stephens-Adamson |
| 1 | Bunker | Parabolic | 1,500 tons | Store coal | | Beaumont |
| 1 | Bunker | Steel | 24x16 ft | Store sawdust | | Stephens-Adamson |
| 1 | Conveyor | Drag-chain | | Sawdust from bunker to flight conveyor | Dr. by 7½-hp. Allis-Chalmers ind. motor | Stephens-Adamson |
| 1 | Conveyor | Flight | 30-in. wide | Sawdust from drag chain to feed pipes | Dr. by 7½-hp. Allis-Chalmers ind. motor | Stephens-Adamson |
| 1 | Elevator | Boot | 10x6 in | Return tailings to bunker | Dr. by 3-hp. Allis-Chalmers ind. motor | Stephens-Adamson |
| 1 | Weigh Larry | Electric, traveling | 2 ton | Weigh coal to stokers | Dr. by 5-hp. Allis-Chalmers ind. motor | Stephens-Adamson |
| 1 | Chimney | Radial-brick | 11-ft. diam., 225 ft. high | Serve boilers | | Custodis |
| 1 | Heater | Open, metering | 120,000 lb. per hr. | Heat feed water | Exhaust steam | Harrison Safety Boiler Works |
| 2 | Pumps | Turbine 3-stage | 250 g.p.m. | Boiler feed | Dr. by 70-hp. Moore turbine | Lea Courtenay |
| 1 | Air compressor | Compound | 1,000 cu.ft. per min. | Compressed air | 125 lb. press.; dr. by 185-hp. G.E. syn. motor | Bung |
| 1 | Air compressor | Compound steam | 1,000 cu.ft. per min. | Compressed air | 125-lb. press | Bung |
| 3 | Heaters | Closed | 3,000 g.p.m. | Forced hot-water heating | Steam atm. press. to 25 lb. | Alberger |
| 3 | Pumps | Centrifugal | 500 g.p.m., 140 ft. head | Forced hot-water heating | Dr. by 175-hp. Kerr turbine | Kingsford |
| 1 | Pump | Centrifugal | 75 g.p.m., 50 ft. head. | Domestic hot water | Dr. by G.E. ind. motor | Gould |
| 1 | Pump | Centrifugal | 175 g.p.m. | Service | Dr. by G.E. ind. motor | Gould |
| 2 | Heaters | Closed | 4,000 g.p.m. | Domestic hot water | 50 to 140 deg. F., live steam | Alberger |
| 1 | Ammonia compressor | Vertical, single-acting | 10 ton, 9x9-in | Cool drinking water | Dr. by 35-hp. G.E. ind. motor | Arctic |
| 1 | Condenser | Double-pipe | 2-stand, 12 pipes high 1¼x2 in., 19 ft. long | Ref. sys. for drinking water | | Arctic |
| 1 | Pump | Triplex | 75 g.p.m. | Circulate drinking water | Motor-driven | Deming |
| 1 | Crane | Traveling | 10-ton | Machine room | Motor-driven | Main's Bros. |
| 2 | Fire pumps | Turbine-type | 1,000 g.p.m., 150-ft. head | Fire purposes | Dr. by 125-hp. Kerr turbine, 1800 r.p.m. | Dayton-Dowd |
| 2 | Pumps | Reciprocating | 500 g.p.m. | 500-lb. hydraulic service | Dr. by G.E. motor | Elmes Eng. Co. |
| 2 | Pumps | Reciprocating | 2,00 g.p.m. | 3000-lb. hydraulic service | Dr. by G.E. motor | Elmes Eng. Co. |

Vulcan soot blowers; Nelson steam and water valves; Havalco blow-off valves; Squires steam traps; Bailey flow meters; precision 3-in-1 draft gages; Uehling $CO_2$ recorders; Foster pressure regulators; Schone sewage ejectors.

one motor-driven centrifugal pump transfer the water from one receiving tank to the other. A 3-in. cold-water makeup line meets any deficiency of feed water, the supply also being controlled by a float in the heater.

Turbine-driven three-stage centrifugal pumps take the water from the heater and deliver it to a 4-in. boiler-feed main, from which two supply lines lead to each boiler, one having regulator control and the other hand regulation. There is a bypass around the heater, so that in case of necessity the feed water may be taken directly from the overhead receiver. Domestic hot water is supplied by two closed heaters taking live steam under thermostatic control.

Three heaters, connected in parallel, were installed to serve the hot-water heating system. Three turbine-driven pumps, each having a capacity of 3,000 gal. per min. against a 140-ft. head, circulate the water. The exhaust steam from the circulating pumps, the air compressors and other pumps in the plant is utilized by the heaters, and when necessary the supply is supplemented with live steam from the boilers. A 12-in. circuit leads to the main building and another 8-in. circuit to the mill building. A temperature differential of 18 deg. is maintained between the outgoing and the return water. The velocity of circulation is varied from 7 to 12 ft. per second, depending on the outside temperature and the heating requirements.

Two compound air compressors supply air to the manufacturing plant at 125 lb. pressure. Either has a capacity of 1,000 cu.ft. of free air per minute. One is driven by compound steam cylinders and the other by a 185-hp. synchronous motor. Either or both may be used to supply the demand, but the intention is to operate the steam compressor during the colder months, when heating is required, and the motor-driven compressor during the summer when no heating of the building is necessary.

Other equipment in the plant includes a 10-ton refrigerator outfit to chill the drinking water, two compressed-air sewage ejectors to raise the drainage from the entire manufacturing plant to the sewage system, and duplicate pumping outfits with accumulators to supply hydraulic service for certain presses in the stamping department. For one of these services a pressure of 500 lb. is maintained and for the other, a pressure of 3,000 lb. Motor-driven reciprocating pumps are employed in each case.

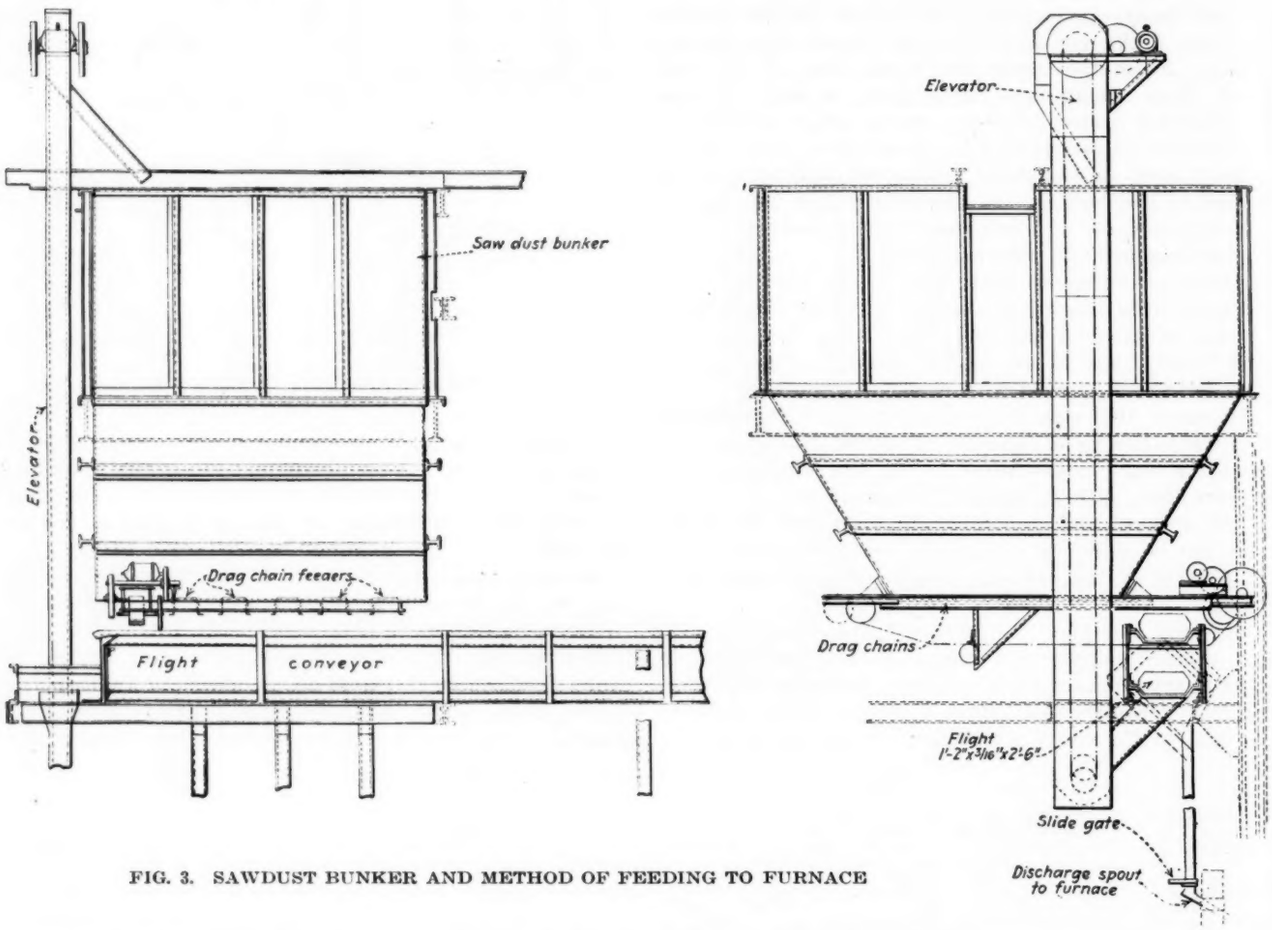


FIG. 3. SAWDUST BUNKER AND METHOD OF FEEDING TO FURNACE

At some future date it is the intention of the company to install an electric generating plant. A duplicate row of five boilers will be added on the opposite side of the present firing aisle, and beyond these boilers will be the generating room, which will have a capacity of 15,000 kva. in three turbo-generators with surface condensers and the usual auxiliary equipment.

At present electrical energy is purchased and is delivered to the main primary switchboard at 11,000 volts, and is then distributed by lead-covered cables in underground conduit to the various substations throughout the plant. At present only such substations are constructed, equipped and in operation as are required by the buildings already erected.

The main primary switchboard is in the basement of

the mill building. It is of the manually operated, remote-control, concrete-cell type. The bus wall is of reinforced concrete 8 in. thick, in which all secondary wiring from current and potential transformers is carried in concealed rigid conduit. Inserts for supporting barriers, instruments and tripping transformers, buses, disconnecting and oil switches, and pipe framework for panels have been provided. The buses are concealed, in transite compartments, and all disconnecting switches are separated by alberene stone barriers. The oil switches are supported by the bus wall and separated by concrete barriers with alberene stone cover.

Distribution of high-voltage service to the substations is underground, ample provision for extension being provided by the installation of spare conduit. The total installed transformer capacity is 9,500 kva., but the ultimate installation will be approximately 15,000 kva., all provision having been made in the present installation for this load.

The project was designed and the erection supervised by Albert Kahn, architect; F. K. Boomhower and J. Gordon Turnbull, associate engineers, Detroit, Mich.

## Installing Conduit in Damp Places

By W. A. Harris

In places where there is considerable moisture there is always danger of water collecting in conduits when they are installed so that certain sections cannot be drained. The method of running wires from the starter to the motor in Fig. 1 is a good one, and can probably be satisfactorily used in ninety-nine cases out of every hundred. When properly done it makes a substantial and neat job. Where there is liable to be condensation on the inside of the conduit, then some other method should be resorted to, since any moisture that forms on the inside of the conduit will drain down

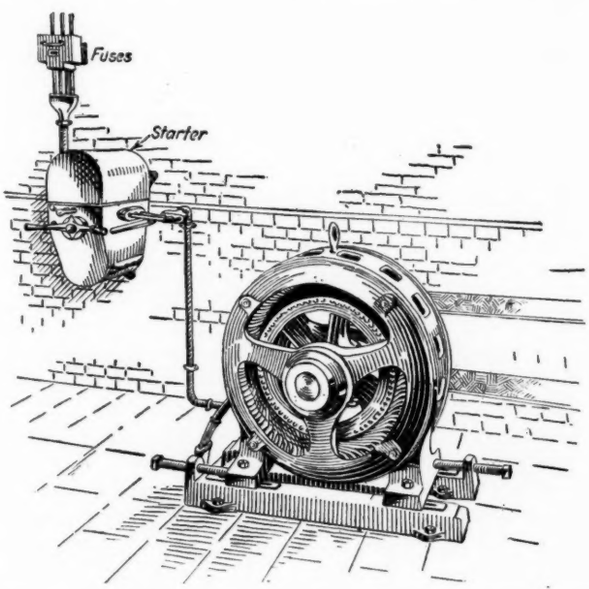


FIG. 1. MOTOR INSTALLATION AS ORIGINALLY MADE

into the section lying on the floor, and here accumulate until the wires become so wet as to cause a short-circuit.

In one case in mind a short-circuit occurred between the motor and the starter in a pumproom. Upon pulling the wires out it was discovered that the conduit was full of water. To overcome this difficulty, the conduit was run up to and across the ceiling and then down vertically to the motor, as shown in Fig. 2. This scheme worked satisfactorily, since it allowed all parts

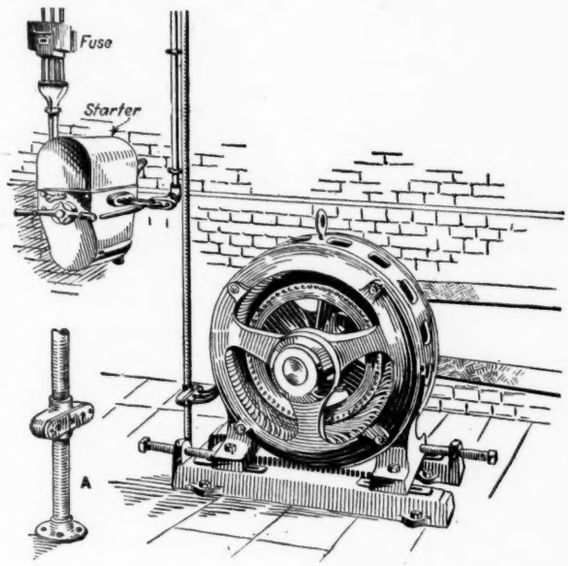


FIG. 2. MOTOR INSTALLATION AFTER REARRANGING CONDUIT AND WIRING

of the conduit to drain. To support the conduit on the floor, it was connected to a floor flange and the wires brought out through a condulet at a point opposite the motor terminals. An enlarged view of the floor end of the conduit is shown at *A*. The chief objection to this arrangement is that it allows a long run of conduit from the ceiling to the floor without any intermediate supports. However, if one inch or larger conduit is used, the construction is fairly substantial. Of course the conduit is standing out in open space and is not the most pleasing thing to look at, but the arrangement prevents trouble and this is one of the chief considerations.

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For cleaning scale from boilers a Western railway shop has adopted a sand-blasting system that prevents dust and sand from being blown about, which is such an objectionable feature of ordinary sand-blasting. The sand is placed in a closed tank on a wheeled truck which is brought up to the work and then there is turned in on top of the sand a head of air sufficient to force it through the hose into the air gun. Water at 125 lb. pressure and air at 90 lb. force the sand out of the nozzle of the gun against the flues and other parts of the boiler, cutting away the scale as if it were mud. The scale thus cut away and the sand are carried off by the water.

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Various methods have been developed for heating the spider of large-sized electrical machinery before pressing it on the shaft. One of the latest methods of doing this is by wrapping it circumferentially with bare copper wire on asbestos. When an alternating current is passed through the wire a secondary current is induced in the iron spider, which heats it up. The spider acts as a short-circuited one turn secondary winding.

# The Regulation of Air Compressors

## A Discussion of Various Arrangements Used To Control the Amount of Air Delivered by the Compressor

THE load on an air compressor, as on the steam engine, varies over wide ranges. If the machines using the air cease operation, the receiver pressure will rise rapidly and unless the flow of air from the compressor to the receiver is decreased, the receiver relief valve will blow, causing a loss of air that has been compressed at the expense of power. As a precaution against accidental excess pressure a relief or safety valve is a necessary adjunct to any air plant, but to use it constantly as a relief for an oversupply of air is wasteful of the power consumed in operating the compressor. For these reasons practically all compressors are fitted with some device whereby the delivery of compressed air from the compressor varies with the demand.

The chief methods employed may be divided into the following classes: Suction unloading valve, suction and discharge unloader, unloading compressor inlet valve, regulation of the compressor suction volume, adjustable compression stroke, variable clearance volume.

### Suction Unloading Valves

Many compressors are fitted with a suction line containing a poppet valve, as in Fig. 1. Here the air from the receiver is led to the space under the plunger valve

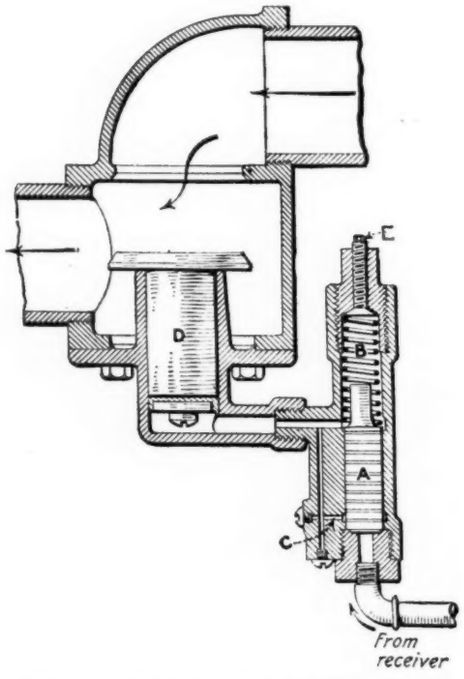


FIG. 1. SUCTION UNLOADING VALVE

*A*. The tendency of the air to shift the plunger upward is resisted by the compression spring *B*. This is so set that at any desired pressure the air acting on the lower face of the valve overcomes the spring resistance and forces the plunger upward sufficiently to uncover the port *C*, whereupon air flows along the passage and forces the valve *D* into the closed position, cutting off the flow of air through the suction pipe of the compressor. The passage *C* is somewhat restricted to prevent a too rapid flow of air, and as a consequence, the movement of the valve *D* is slow. At a drop in pressure the plunger *A* is forced downward by the spring, closing the passage *C*, and *D* moves to the open position as the trapped air escapes through the upper part of the regulating valve.

This design of regulator prevents air from entering the compressor cylinder when *D* is closed, and the machine runs along without load as long as the valve is closed, the air inside the compressor being compressed

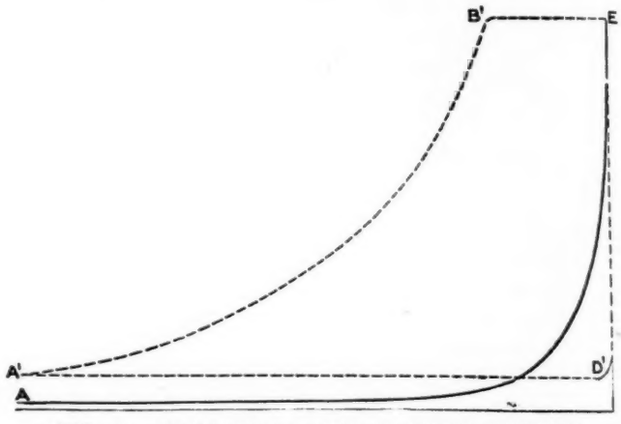


FIG. 2. INDICATOR DIAGRAM WITH SUCTION UNLOADING VALVE

and re-expanded as long as the valve *D* is closed. An indicator diagram from a compressor with this device would appear similar to Fig. 2, where the no-load conditions with clearance are shown by the solid lines *AE*, where the compression and re-expansion lines coincide, and the full-load compression, discharge and suction lines form the diagram *A'B'ED'A'*. Theoretically there is no loss occasioned by this method of regulation. The expansion and compression of air trapped in the clearance space should follow the same line. The disadvantage of this system of regulation lies in the rapid change from no load to full load. If the bearings are at all loose, the machine will pound as the unloader valve opens. With a compressor driven by a gas or gasoline engine, rapidly varying load conditions are by no means conductive to proper combustion and if driven by a direct-current motor might cause commutator troubles. The flywheel should be heavy enough to absorb part of the load fluctuation. The desired receiver pressure may be maintained at any predetermined value by adjusting the screw plug *E*.

### Suction and Discharge Unloader

Some compressors are provided with both a suction and discharge unloader. The suction loader is a modification of the unloader in Fig. 1. The discharge air chambers of the compressor are equipped with a check valve, as in Fig. 4. The check valve is mounted in a cage which contains a spring-loaded piston and plunger. Where the receiver pressure rises above the desired voulme, the pilot valve opens, allowing the air pressure to close the suction unloading valve and at

the same time the piston and plunger in the discharge unloader are forced up by the air pressure. This movement lifts the ball-check valve, and the air in the compressor cylinder has a free exit to the atmosphere through the check. When the receiver pressure drops

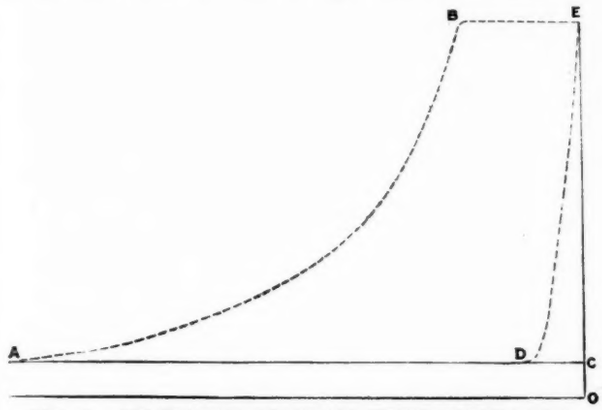


FIG. 3. INDICATOR DIAGRAM WITH DISCHARGE UNLOADER

to normal, the check valves close, while the suction unloader opens, and the compressor begins delivering air to the receiver.

The indicator diagrams of a compressor with clearance at full and no load appear in Fig. 3. The full-load diagrams are shown by the dotted lines *ABED*, while the no-load diagram consists of a single line *AC* at atmospheric pressure.

### Unloading Compressor Inlet Valves

In place of completely reducing the air supply to the compressor, many modern compressors are fitted with inlet valves which, on no-load, are held open during both the suction and compression strokes. This

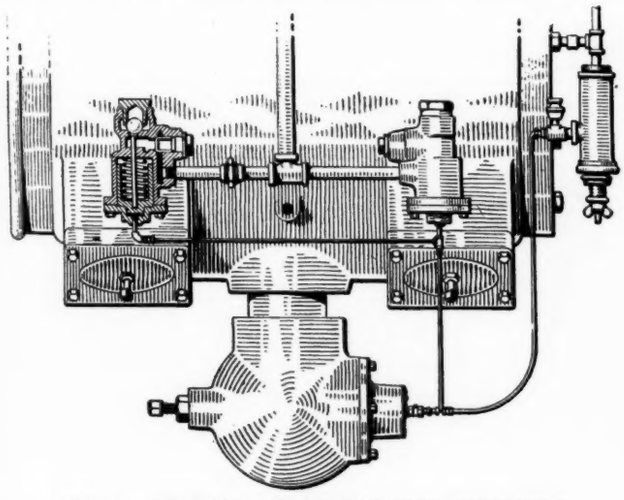

FIG. 4. SUCTION AND DISCHARGE UNLOADER

arrangement is shown in Fig. 5. In the event of a high receiver pressure the air acts on the valve *E*, overcoming the spring resistance. The opening of this valve allows the air to flow along the piping and to force the plunger *C* downward. The plunger rests on the spider *A* which, in moving downward, holds open the inlet valve *B*. Under these conditions the inlet air that flows in through the valve *B* is forced back through the valve when the piston starts the compression stroke. No work is done by the compressor save that of overcoming the frictional resistance through the valves and ports. The no-load and full-load diagrams would be as shown in Fig. 3, where *ABED* is the full-load diagram. The no-load diagram consists of a straight line *AC*, showing that the pressure on both sides of the piston is the same.

### Variable Compression Volume

As a means of securing regulation without any of the disadvantages possessed by many systems, the cylinder shown in Fig. 6 has been adopted by one

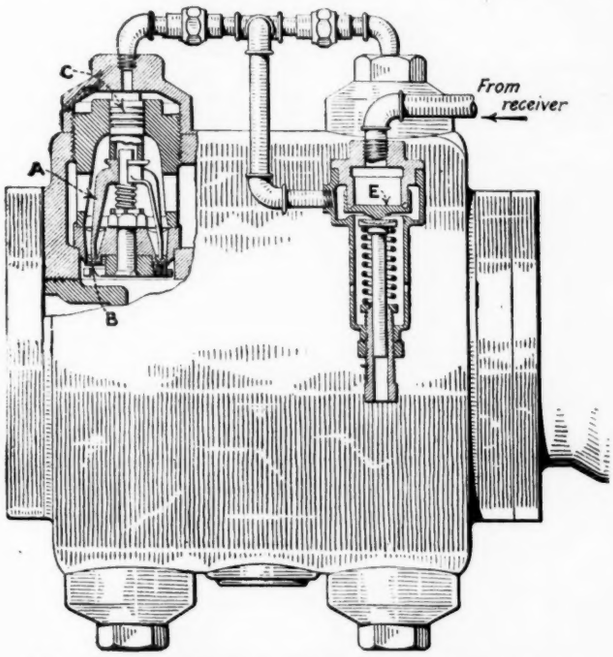


FIG. 5. COMPRESSOR INLET UNLOADING VALVE

manufacturer. It is fitted with four sets of inlet valves, each set connected to a spring-loaded pilot air valve. The compressor piston is made sufficiently long to cover the *B* valves at crank dead center and the *A* valves on

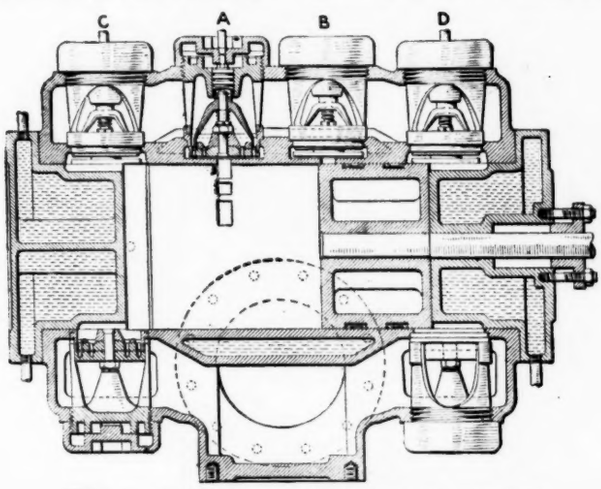


FIG. 6. VARIABLE COMPRESSION VOLUME

the head dead center. If the receiver pressure rises, the pilot valve admits air above the plunger of inlet valve *A*, holding this valve open. The piston forces the air back through the valve until the latter is covered by the advancing piston, whereupon the compression

in the head end starts. On the return stroke the compression occurs during the entire travel of the piston. If the received pressure still increases, the pilot valve connected to inlet valve *B* admits receiver air to hold valve *B* open. The compression in the crank end now begins when the valve *B* is covered. At a further

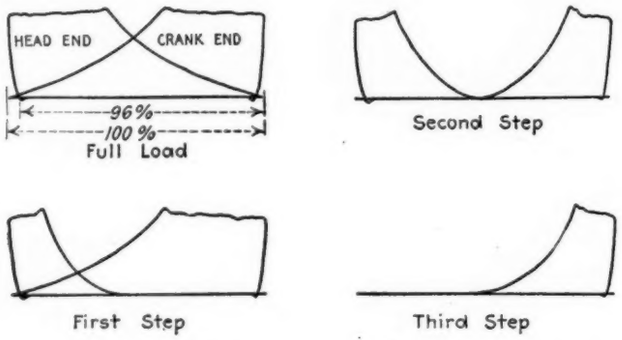


FIG. 7. INDICATOR DIAGRAM WITH VARIABLE COMPRESSION VOLUME

increase in receiver pressure valve *C* is held open, and compression takes place in the crank end only. With no-load conditions all the valves are held open. In Fig. 7 are shown indicator diagrams with four valve conditions. On no load all inlet valves are held open and the diagram is of course merely a horizontal line at the

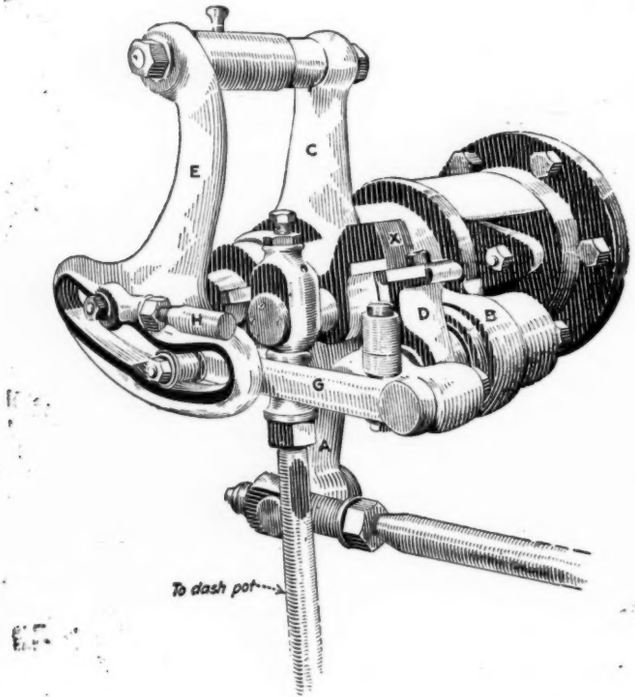


FIG. 8. VARIABLE SUCTION VOLUMES

suction pressure level. The system is used with compound compression, both cylinders being fitted with the four sets of valves.

### Variable Suction Volume

Still another system is outlined in Fig. 8, where the Corliss-type inlet valve is held open during a portion of the piston stroke as determined by the receiver air pressure. This is an adaptation of the Corliss steam valve with variable cutoff. Here a rocker *C* mounted on the valve spindle has a lever *B* carrying the pick-up block *D*, and an arm *A* which is connected to the compressor wristplate. The pick-up block *D* engages with the valve block *X*, and as the eccentric through the wristplate moves *A* and *D*, the valve is opened. The block *D* is supplied with a lever *G* having a roller

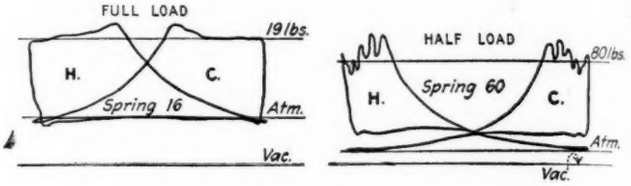


FIG. 9. INDICATOR DIAGRAM WITH VARIABLE SUCTION VOLUME

engaged in the slotted cam *E*. This cam *E* is controlled by the link *H*, which is actuated by the receiver air moving a weighted piston. An increase in pressure shifts the cam *E*, whereupon the upward movement of *G* as it travels along the cam moves the pickup block *D* from contact with *F*. The valve is then closed by the dashpot as with the ordinary Corliss steam-engine valve.

The early closure of the inlet valve stops the flow of air into the cylinder. Half- and full-load diagrams appear in Fig. 9. On low loads the air after cutoff expands to the end of the piston stroke. The compression on the return is along the same curve, and little if any power is lost by this method of control. It is, however, only applicable in the case of slow-moving machines, since at high speed the valve mechanism will be noisy.

### Variable Clearance Regulation

A recent development in compressor regulation is the variable clearance control. The compressor cylinder, Fig. 10, is equipped with clearance valves *ABCD*.

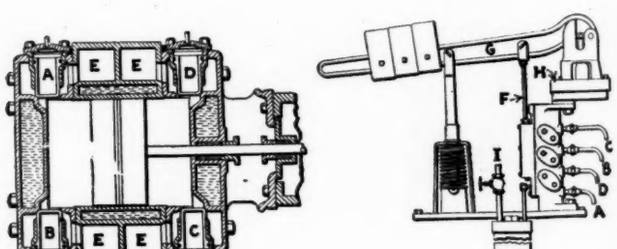


FIG. 10. VARIABLE CLEARANCE COMPRESSORS

These valves open communication between the cylinder and the clearance spaces *EE*. The cages inclosing the clearance valves are piped to the regulator shown at the left.

If the receiver pressure is above normal, the regulator opens a bypass *A*, allowing the air above the clearance valve *A* to escape to the atmosphere. As a consequence the air in the cylinder is compressed by the piston into a space consisting of both the cylinder volume and the clearance chamber *E*. The net volume of air at the receiver pressure forced out of the cylinder

is now less than when the valve *A* is closed, since part of the air is left in the clearance pocket. On the return stroke this clearance air re-expands and none of the work of compression is lost. If the receiver pressure continues to rise, a second clearance valve *B* is

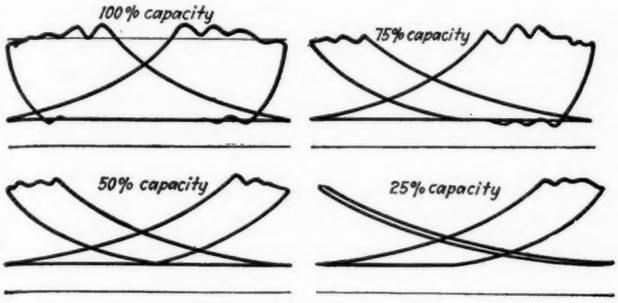


FIG. 11. INDICATOR DIAGRAM WITH VARIABLE CLEARANCE

opened, reducing the volume of air from the crank end going to the receiver. The arrangement of the four pockets give five load points. The indicator diagrams at these several load points are shown in Fig. 11.

## Supporting Horizontal Return-Tubular Boilers

It is common to support horizontal return-tubular boilers by means of four or more brackets resting on brickwork, or by suspending it at four points from two overhead steel beams resting on columns. When this is done, says F. W. Dean, it is impossible to adjust the loads so that they will be equal at each point, and in fact, three of them, sooner or later, will support the whole load, especially if the foundation settles. This shows the folly and danger of using anything but the "three-point suspension," provision for which should be made in the first place. When the boiler itself determines the three points, one support will be overstrained. A three-legged stool rests firmly upon any irregular surface and is as stable if one or more points settle.

The "three-point suspension" was originated by the late Orosco C. Woolson, of New York, and for this he has not been sufficiently honored. When the three-point suspension has been carried out, connection has been made to four points on the shell, but the two rear points have been connected to an equalizing beam above, which has been hinged to the beam resting upon the supporting columns. A simpler, better and cheaper method is to have the rear end supported by a bracket riveted to the rear head of the boiler, as thereby harmful stresses will be removed from the shell and none added to the head. From this bracket a rod would pass to the supporting beam above.

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Recording instruments in boiler rooms are not installed as ornaments; they are put there to show what is going on at points where such information is essential to proper operation. An idle instrument is usually a reflection on the engineer who operates the plant. If the management is sufficiently alive to the requirements of modern boiler-room practice to purchase a recording instrument, the operating engineer should do his share by giving it what little time and attention is required to keep it in operation. Then the readings should be used to control operation.

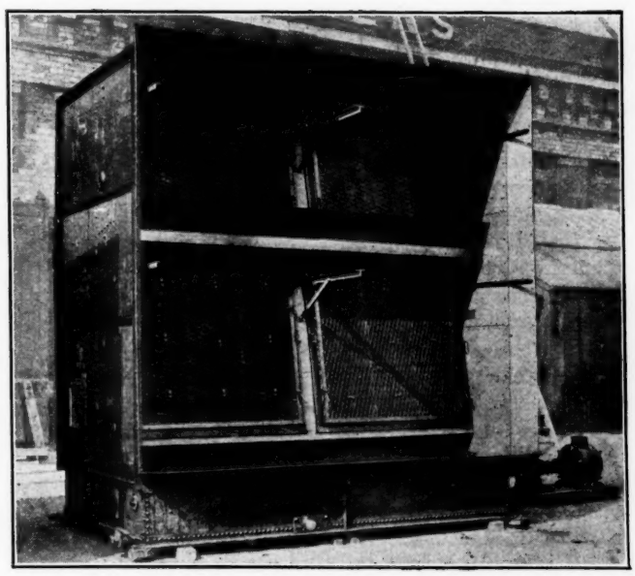
## Heenan Stationary Air Filter Delivers Air Free of Moisture

Filtered air used for ventilating turbo-generators if of the wet-air variety may be discharged into the generator winding while containing loose moisture which eventually may destroy the insulation. To overcome the possibility of moisture being delivered to a generator in the air, a type of filter known as the Heenan stationary air filter, manufactured by Heenan & Froude, Ltd., Worcester, England, has been designed.

The illustration shows the filter. It is rectangular in shape, built up of steel plates, stiffened where necessary with angles and suitably mounted on a substantial base, the latter forming a tank. The filtering effect is obtained by drawing or forcing the air through two sets of screens, fitted one behind the other, in the front part of the filter, these screens being formed of metallic wool held between metal frames.

To insure that the air is thoroughly cleansed, a flow of water is continually passed over the screens, being maintained by a small centrifugal pump fitted at the side of the filter, which delivers the water to the top of the screens. The water, after percolating through the screen, falls into the tank at the bottom of the filter, where it passes through a strainer and returns to the pump to be recirculated. The screens are easily removed for cleaning purposes, but as they are continually washed with water, the dirt is carried with the water to the bottom of the filter, from which it can be removed through sludge doors.

After going through the screen, the air passes a series of fixed eliminators, which catch any small par-



FILTER WITH FRONT REMOVED, SHOWING FILTERING SCREENS

ticles of loose moisture that may have passed the second screen. The total resistance to the passage of air through the machine does not exceed 0.75-in. of water.

The water level in the base or tank is maintained by a float valve connected to the water supply, the amount of water used being the amount lost by evaporation in passing through the filter. This type of filter is designed in thirteen standard sizes, ranging in capacity from 1,300 to 75,000 cu.ft. per minute.

# Important Facts Regarding Fatigue of Metals

## Investigation Discloses Definite Stress Limit Below Which Failure Cannot Occur On Account of Continuous Vibration or Rotation

FOR two years there has been in progress at the University of Illinois a joint investigation on the fatigue of metals. The experiments have been conducted under the auspices of the National Research Council, the Engineering Foundation, the General Electric Co. and the Engineering Experiment Station of the University of Illinois. Bulletin 124, just published by the Engineering Experiment Station of the University of Illinois, contains a progress report of this work which promises to revolutionize the commonly held ideas regarding the failure of metal under repeated stresses.

The investigations thus far have been confined to various commercial grades of iron and steel. Within these limits the tests made have been extensive, and the results already obtained promise to be a decided aid to the designers and manufacturers of equipment subjected to stresses that are reversed many thousands of times daily. In the power-plant field the investigation is of particular interest to the designers of steam turbines and other high-speed machinery. It may also have some bearing on boiler design.

The general problem set was to find out, by a series of long-time, reversed-stress tests of several kinds of steel, together with careful static tests of the same steel, what relation exists between the static elastic strength of the steel and its ability to withstand millions of reversals of stress. A secondary problem was to try various tests commonly used on steel (such as impact tests and hardness tests) to see whether any of these give indications of the ability of the steel to withstand continuous vibration.

### Method of Testing

The main series of tests—those with the reversed stresses—were conducted with a testing machine of the rotating-shaft type. With this apparatus the piece to be tested is made in the form of a shaft which is supported at the two ends by self-aligning bearings and rapidly rotated while a bending load of any desired amount is applied halfway between the bearings. This portion of the shaft is slightly reduced in diameter, so that the break will occur there. It will be seen that the stresses in such a test piece are similar to those in a turbine shaft supported between two self-aligning bearings and carrying a heavy wheel. This, of course, puts the top of the shaft under compression and the bottom under tension. When the shaft is rotating, each point in the circumference of the section where the load is applied, undergoes rapid reversal of stress from compression to tension. It is a well-known fact that a shaft rotating in this manner will eventually fail under a load that it could stand indefinitely if it were at rest.

In making the tests for a given kind of steel, a large number of identical test pieces were prepared. A piece was selected and loaded heavily to insure failure in a short time, then it was rotated until it gave way. The number of revolutions required to cause this was recorded by a counter. With successive test pieces the load was gradually reduced until one was reached where the specimen stood 100,000,000 revolutions without failure. Wherever possible, these long-duration tests were run on from three to five specimens of each variety of steel investigated.

These tests showed, for all varieties of steel and iron tested, that the number of revolutions required for failure increases uniformly as the load is decreased, until a certain load is reached, and that a slight reduction from this particular load makes it impossible to break the piece, even when run up to 100,000,000 revolutions. The point at which this occurred was called the endurance limit. In every case the endurance limit developed at a load where less than 10,000 revolutions would cause failure, and yet in no case was it possible, after slightly decreasing the load below this point, to cause failure even with 100,000,000 revolutions. On account of the suddenness and size of this jump it is reasonable to suppose that, below the endurance limit, the rotation could be continued indefinitely without causing the piece to fail.

### Other Indications of Endurance Limit

Other tests were made of the elastic limit, ultimate strength, yield point, Brinell hardness, etc., to see if there was any definite relation between endurance limit and any other property of the metal. The Brinell hardness test was the only one that showed a consistent relation. In addition, a special test, called a rise-of-temperature test, was developed which indicated the endurance limit even more closely than the Brinell hardness test.

Previous investigators have found that the shape of the specimen has a great influence on the endurance strength of a material. Square shoulders and notches are known to reduce greatly the strength of pieces subjected to reversing stresses. In this investigation it was found that a square notch reduced the strength 51 per cent, and a V-notch reduced it 60 per cent. Even the degree of polish had a noticeable effect. For instance, it was found that rough-turned specimens had an endurance limit 18 per cent less than that of specimens with a rough polish.

In the foregoing outline it has been possible to touch only a few of the high spots of this report, but enough has been given to show that the investigation is of decided interest to those who are concerned with the selection and use of metal for high-speed machinery.

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It is a great mistake, says F. W. Dean, to make the tubes of horizontal return-tubular boilers over 3 in. in diameter. By using larger tubes less surface is provided in a given boiler, the gases are not split up in small streams and do not so well impart their heat to the boiler, and the gases have a better opportunity to utilize a part of the tubes. All of these things reduce efficiency. If the coal has a good deal of volatile matter the case is not altered, and the use of 4-in. tubes, which are employed west of the Hudson River, is a mistake. If small tubes are likely to become stopped by soot with western coal it is advantageous because it compels the tubes to be kept clean.

# Largest Impulse Turbine Units in Caribou Station

By W. M. WHITE
Manager and Chief Engineer, Hydraulic Department, Allis-Chalmers Manufacturing Company

*Two of the largest impulse-wheel-driven units in the world, rated at 30,000 hp. each and operating under 1,008-ft. head at 171 r.p.m. have been installed. Unit consists of two independent wheels, one on either side of the generator. Reliability and simplicity were the dominant features influencing the installation of impulse wheels rather than the more efficient and smaller reaction turbine.*

IN THE Caribou Station of the Great Western Power Co., Belden, Cal. (See Fig. 1) the machinery installed is notable because the units are the largest impulse-wheel-driven machines in the world, having a normal capacity of 30,000 hp. each under 1,008-ft. head, at 171 r.p.m. They possess possibly even greater interest by reason of the considerations leading to the selection of the impulse type for conditions to which a reaction turbine could be applied. This latter feature is of interest in view of the growing application of the reaction, or so-called Francis type, for heads between 500 and 1,000 feet. It is only for the last few years that the application of the reaction wheel to high heads has been considered good practice. In 1905 the installation of a capacity of 9,700 hp. in a single reaction runner under 550-ft. head at the Centerville plant of the California Gas & Electric Co. was severely criticized in many quarters, as it meant pioneer engineering work far ahead of any precedent in the way of capacity or head for the type in question. Similarly, the 13,000-hp. 375-ft. head single-runner reaction turbines installed in the plant of the Great Northern Power Co. near Duluth, Minn., were openly received with considerable skepticism on the part of many engineers. These two plants, together with the 440-ft. head 10,000-hp. units installed in the Grace plant, Idaho, of the Telluride Power Co., gave the engineering world the first assurance that such construction could be installed successfully and operated with commercial economy. Since that time heads up to 600 ft. have been developed regularly, using the reaction type of wheel unless the capacity of the units was very small. More recently, higher-head units have been installed, notably the 680-ft. head unit of 30,000 hp. in the Big Creek plant No. 8 of the Southern California Edison Co. and the 22,500-hp. units under 800-ft. head installed in the Kern River plant No. 3 of the same company. Operating data on plants using reaction runners for heads as high as 800 ft. are lacking, but the leading turbine builders of the country are willing to offer large capacity units for heads probably up to 1,000 feet.

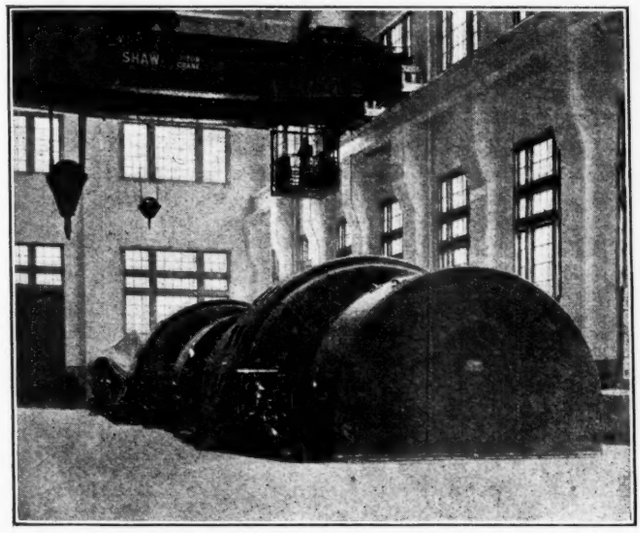


FIG. 1. VIEW OF THE CARIBOU STATION.

The entire question involved is simply a comparison of the advantages of first cost, small floor space and higher efficiency obtainable with the reaction type of units against the greater simplicity, smaller liability toward wear and greater ease in renewing wearing parts obtainable with the impulse type.

Between the two types available, the choice for the Caribou plant was made after an extensive series of studies as to different types. For example, a multiple-runner impulse wheel possessed certain advantages from the viewpoint of gain in generator efficiency, owing to the higher speed and saving in first cost due to that feature, and owing to the smaller size of working parts of the wheels. It was discarded on the over-all consideration that it was not the simplest arrangement that could be worked out and would not incorporate the fewest number of working parts. It was considered that these features in the long run would introduce elements of wear and complications that would defeat the economy effected by the higher speed. The reaction unit was studied carefully, and in contrast with the unit adopted, Fig. 2, effected considerable saving in floor space and in the machinery proper. It also possesses efficiency characteristics in excess of those obtainable with the impulse type, and all the parts to be handled during erection and during any dismantling for renewal of working parts are considerably lighter. The unit adopted, however, is a double-overhung impulse turbine, each wheel of which is driven by a jet from a single-needle nozzle. There are but two bearings in the unit, the generator rotor being carried between them, the wheels being carried on an overhang of the shaft outside of the bearing. This gives a compact and simplified arrangement with the fewest number of working parts.

Prior to this installation the largest impulse wheels in the world were the 20,000-hp. 2,000-ft. head units installed in the Big Creek plants Nos. 1 and 2 of the Pacific Light and Power Corporation. They are of the same general arrangement as the units in the Caribou Station and were designed by the same engineer. The Big Creek units possess physical dimensions considerably smaller than those of the Caribou units. For example, the jets were in the neighborhood of 6 in. in diameter, whereas the nozzles of the Caribou units are

capable of delivering jets 11 in. in diameter. Both installations, however, possess common characteristics, such as the same type of double overhung construction, the same type of needle regulation, and double arrangement of the governors and the pressure regulators.

Incidentally, it may be mentioned that within one month from the time the units were first turned over for drying out, the erecting superintendent had left the plant and the units were carrying full load. They have been in service continuously since their initial start

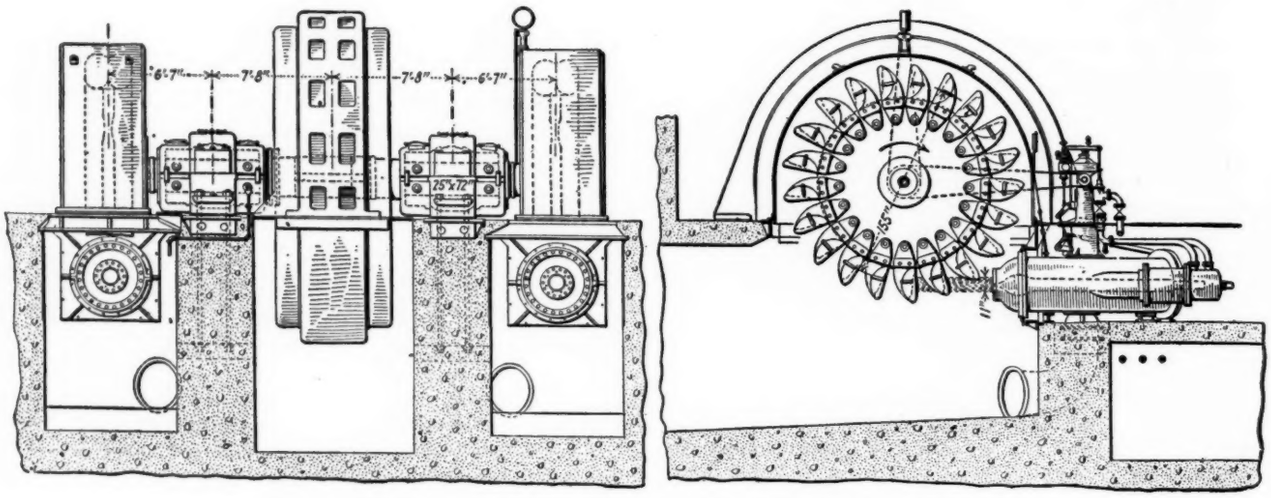


FIG. 2. DOUBLE-OVERHUNG IMPULSE TURBINE FINALLY ADOPTED

It was largely the successful performance of the Big Creek units, together with a conservative policy in adhering to the most sturdy and reliable type of machines, that led to the selection of the impulse type for the Caribou Station rather than any refined analysis and have developed in excess of 35,000 hp. under emergency conditions.

Each unit consists of a generator and two impulse wheels, one placed on each end of the shaft. These wheels are independent in their action, each having its

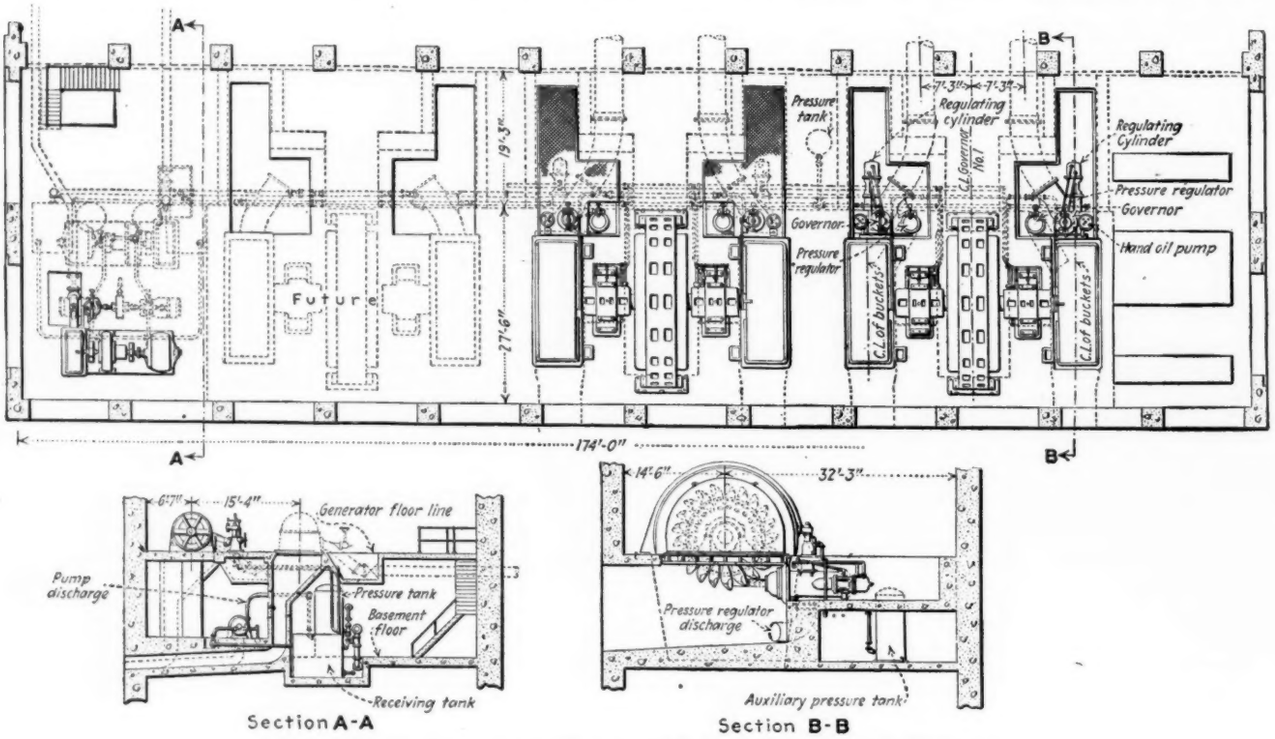


FIG. 3. GENERAL LAYOUT OF THE CARIBOU POWER STATION

of efficiency only. In other words, reliability was the dominant feature influencing the decision.

The general arrangement of the units in the plant is shown in Fig. 3. Two units are now installed, having been officially started in operation in June of this year. own needle control, oil-pressure governor, pressure regulator and gate valve. In other words, the governors and pressure regulators are not interconnected, except that the former have their flyballs driven from the same shaft.

For bypassing the water in case of quick closure of the needle by the governor in response to a certain rejection of load, the pressure regulator is built as a governor-actuated water-saving device, thus responding only to quick motion of the needle controlled by the speed governor. However, the pressure regulator is also automatically pressure operated in order to protect the pipe line against serious pressure rises produced directly in the pipe line, such as may occur when foreign matter lodges in the throat of the nozzle and partly clogs the orifice. This is effected in a simple manner, requiring no additional device on the pressure regulator.

The two governors of each unit divide the load evenly between them, owing to the fineness of adjustment provided for permitting this division and owing to their high sensitiveness. They are not mechanically or hydraulically interconnected, each being actuated by its own flyball independently and each operating the cylinder and piston which controls the needle of the nozzle. It was observed at Big Creek, for instance, where the same arrangement is used, that the two governors of one unit returned to within about $\frac{1}{10}$ of the whole governor stroke and with an adjustment of the relay of $\frac{3}{4}$ of 1 per cent between full load and no load. It follows that the sensitiveness of these flyballs must be at least $\frac{1}{10}$ of $\frac{3}{4} = 0.015$ of 1 per cent, a sensitiveness that cannot often be found even in connection with governors for steam turbines.

Main physical dimensions of the unit may be visualized from the following: The nozzle inlets are 38 in. inside diameter and they are connected to the penstock

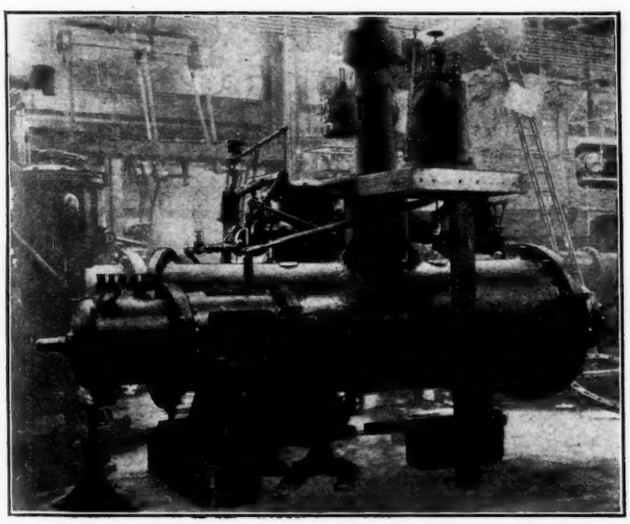

FIG. 4. REGULATING CYLINDER WITH AUXILIARY CONNECTION

by long-radius elbows expanding from 38 to 42 in. The hydraulically operated valves are 42 in. in diameter and are located immediately outside of the power house. The mainshaft is approximately 30 ft. long, 24.75 in. in diameter in the bearing and of a maximum diameter of 30 in. The journals are 72 in. long. The impulse wheel has 21 buckets, each approximately 3.5 ft. wide. In over-all dimensions the unit occupies a floor space 40 x 30 ft.

The nozzles are of the stationary type, needle controlled and with steel and bronze wearing rings throughout. The needle tips and nozzle throat rings are arranged to be readily renewable. The needle stems are extended directly backward and form the piston rods of the regulating cylinders, eliminating all intermediate connecting parts. The nozzle bodies are of cast steel and were given a shop test of 750 lb. per sq.in. Some idea of the stresses involved can be formed from the consideration that the force that tends to separate the flanges of the nozzle hood is in excess of one-half a

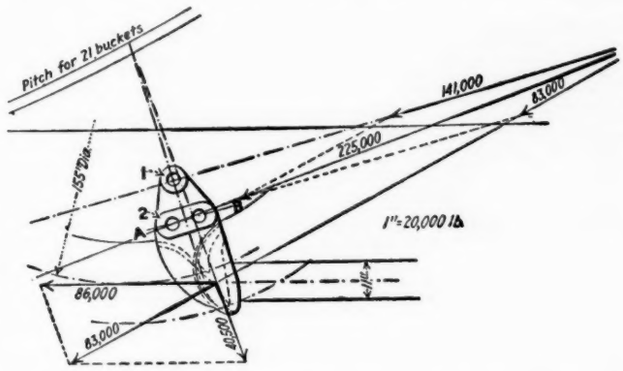


FIG. 5. DIAGRAM OF FORCES IMPOSED ON BUCKET DURING NORMAL OPERATION

million pounds. The regulating cylinder together with auxiliary connection is shown in Fig. 4.

Of all portions of the unit the rotating element presented the greatest problem. The buckets weigh 1,000 lb. each, and under extreme conditions of speed the centrifugal force is approximately 63,000 lb. Under normal conditions of speed and with full load on the unit the forces imposed on these buckets are shown diagrammatically in Fig. 5. The full load on each bucket represents an impact of 86,000 lb., and when it is considered that this force is an intermediate one—that is, it occurs 171 times per minute—the question of stress becomes vital. Some conception of the extent of this force can be had by considering that each bucket receives an impact from a mass of water possessing energy equal to that of a 2,000-lb. automobile going at the rate of 50 miles an hour, or a loaded 5-ton truck at 22 miles an hour, and brought to a dead stop within a distance of less than 6 ft. Considering further that these automobile equivalents smash against each of the 21 buckets 171 times a minute, 24 hours a day and perhaps for months at a time without a single intermission, some conception may be formed as to the punishment to which the bucket and its fastenings are subjected.

Too much attention cannot be paid to the proper method of fastening the buckets to the wheel disc and of properly determining size, number and location of the bolts that hold each bucket in place. Considering that the centrifugal force under normal operation is 46,000 lb. per bucket and that the impact force during the period of impingement of the jet upon a bucket is 86,000 lb. for about $\frac{1}{20}$ of a second, it follows that the bolts are subjected repeatedly to an exceedingly quick and hard hammer blow and if they are not properly dimensioned and of proper material, their sectional area will be reduced so that they will finally become loose. This is a dangerous condition and rapidly leads to the destruction of the bolt, ultimately resulting in a serious accident in the power plant.

A bucket which "sings" is one that is almost sure to fail, besides being disagreeable by reason of the noise produced. Elaborate experiments were made in de-

signing these buckets in order to determine their acoustic properties. When the final design of bucket was arrived at, the material properly selected to give the greatest rigidity and freedom from vibration when combined with the necessary bolts and lugs, it was possible to proceed with the design of the bolted connections. These bolts are each machined for a pressed

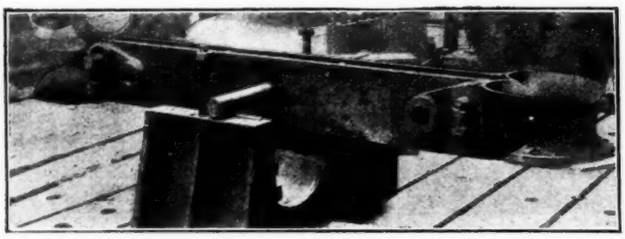

FIG. 6. SHOWING METHOD OF BALANCING IMPULSE-WHEEL BUCKET

fit of approximately 50 tons each, all holes being reamed together with the buckets and discs and the bolts turned to size thereafter.

The buckets were balanced both as to weight and as to position of center of gravity. The method used is shown in Fig. 6. Each bucket is bolted to a lever of the same radius as that of the wheel and is balanced against a sample bucket of fixed weight placed on the opposite lever arm. This balancing was carried out after the inside or bowl of the bucket was ground to a dead smooth and clean metallic surface free from any flaw or pinhole that might serve to start erosion of metal.

Approximately 11 ft. in diameter and 7 in. thick, the disc is made of oil-tempered forged steel of special high tensile characteristics. The disk is pressed on a cast-steel hub and bolted to it by means of reamed bolts each machined for a pressed fit of 50 tons. The hub in turn was finally pressed on the shaft with a press fit of 200 tons and keyed and locked in place.

After assembly of the wheel and hub together with the buckets and bolts, it was mounted for balancing as shown in Fig. 7. The initial balance of this wheel was such that a 2-in. nut placed in a bucket on one side would cause complete rotation of the wheel.

The shaft is compression forged of open-hearth steel having a tensile strength of approximately 75,000 lb. per sq.in. It was given special heat treatment and hollow-bored to insure perfectness of metal. The billet from which it was made weighed 50 tons and the finished shaft 26 tons.

Support is afforded the shaft by two heavy-duty bearings carrying the 160,000-lb. generator rotor and two 55,000-lb. wheels. Under full-load conditions each bearing carries a total load of 200,000 lb. They are of the self-aligned babbitted type with heavy oil rings and have water-cooled shells. In addition they are equipped with forced feed, which may be used for starting in emergency or may be used continually if necessity demands. The housing is of simple plate-steel construction, mounted on a cast-iron base ring which is in turn bolted to the bearing proper. It is reinforced to prevent breathing action and it is stiffened to eliminate resonance.

Governors are of the oil-pressure type, equipped with all the refinements, such as a relay for hand operation and remote electrical switchboard control, load-limiting device to enable carrying constant load irrespective of the load demand, and a safety stop which causes the governor to close the needles in case of breakage of the belt driving the speed governor.

For these governors the oil pressure is furnished by a central oil-pressure system, the arrangement of which is such as to practically preclude interruption in service. The oil pumps are of the rotary-gear type especially developed for this particular kind of service, reliability in operation being the first requirement. Each pump is directly connected to an electric motor, but the two pumps are also arranged so that in case of failure of electric current the operation of the pump is not interrupted.

Each of the two exciter units is rated at 800 hp., operates at 600 r.p.m. and is of the usual horizontal-shaft single, overhung impulse type.

Some interesting problems were introduced in the field assembly of these units by reason of the heavy press fits of the generator rotor on the shaft and the necessity of leaving off one of the impulse wheel hubs to permit of putting the generator rotor in place. These press fits were made by means of heating the outside piece in a steam chamber, thereby reducing the amount

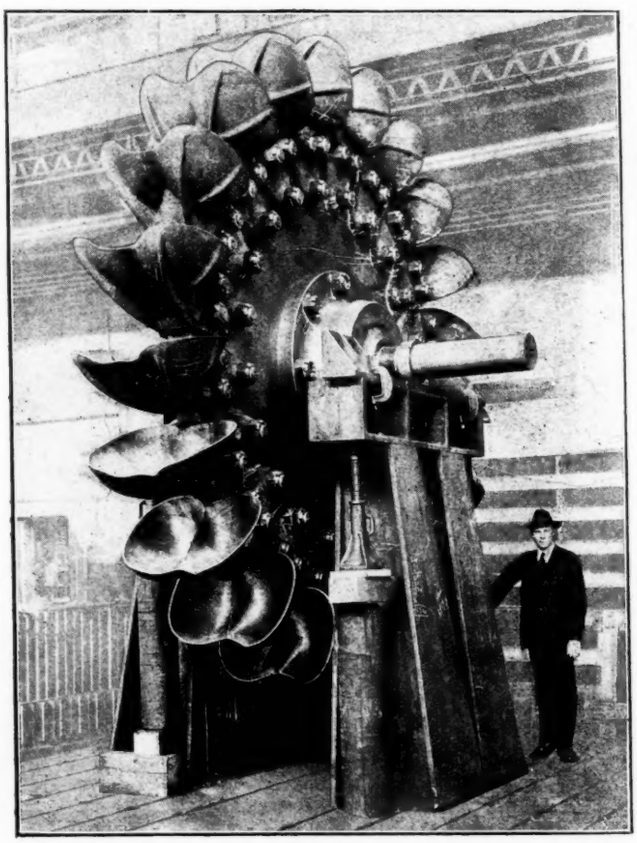

FIG. 7. FINAL BALANCING OF WHEEL WEIGHING ASSEMBLED 25 TONS

of force necessary to press it in place. The problem was a difficult one by reason of the size of the parts to be handled and the necessity of operation with little delay when a part had once been heated the required amount. Aside from this feature and that involved by reason of the forces to be handled in case a part stuck, practically no unusual features of erection were encountered.

# Locating Faults in Direct-Current Armatures—Effects of Grounds*

## Various Conditions Under Which Grounds May Occur in an Armature—Causes of Insulation Failure to Ground—Testing for Grounded Coils with a Lamp and How To Cut These Coils Out of Circuit

BY B. A. BRIGGS

GROUNDS in armatures may occur under a number of conditions. The fault may be in either the commutator or the windings. A ground on one commutator segment only, for example, if the insulation between the clamping ring *R* and the bar *A*, Fig. 1, were to fail no serious effects would result unless there is a ground on the power system and the frame of the machine is ground. With a low-resistance ground from the commutator back to one side of the power system, the fuses protecting the machine will be blown or the circuit breaker opened. Under such condition the commutator is liable to be damaged owing to arcing from the segment to the end ring. If the frame of the machine is insulated from the ground—for example, located on a wooden or a concrete floor—its operation will not be interrupted. Where a machine is set on a concrete foundation connected to ground, the insulation resistance of the foundation may be found to be comparatively low—around 100 to 200 ohms. Where such is the case, a ground in the commutator on one bar when one side of the power system is grounded, will allow the current to leak to ground through the fault and will soon carbonize the insulation, and the defect will spread to other segments. This will cause a short-circuit of two or more segments and the coils connected to them. For example, if in Fig. 2 the insulation was to fail under segments *A* and *B* to the end ring *R*, a circuit would be formed between the two segments and through coil *B*, which connects to them. This fault would act as a short-circuit between segments and cause heating of the coil *B*, which is connected to the segments. A closed circuit is formed from segment *B* through the top half of coil *B* around through the lower half of this

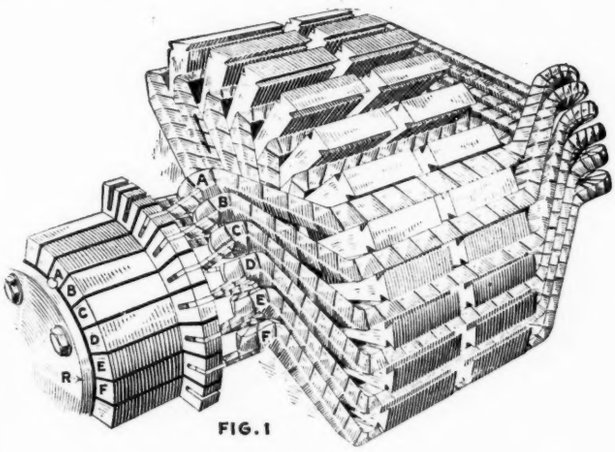

FIG. 1

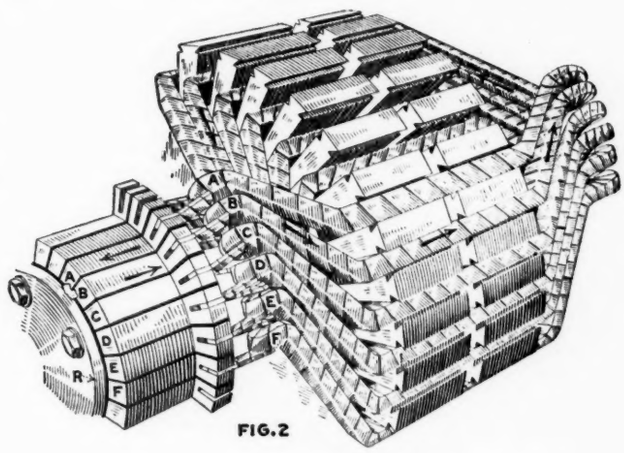

FIG. 2

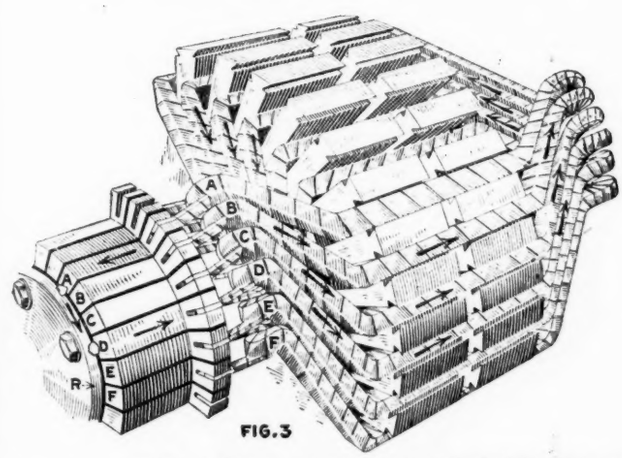

FIG. 3

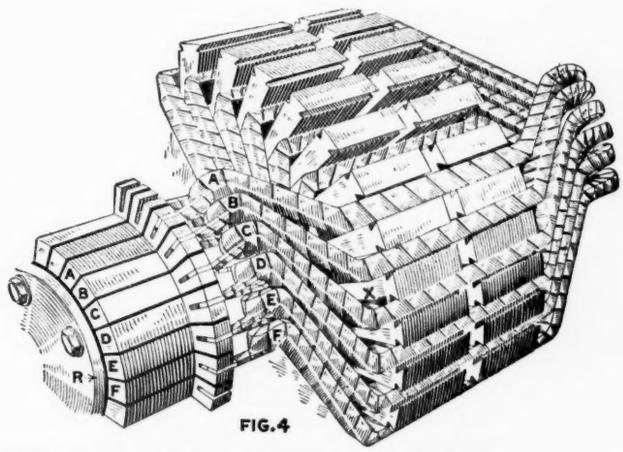

FIG. 4

FIGS. 1 TO 4. SHOW HOW GROUNDS IN VARIOUS PARTS OF THE ARMATURE MAY OCCUR
Fig. 1—Segment *A* grounded to end ring *R*. Fig. 2—Segments *A* and *B* grounded to end ring. Fig. 3—Segments *A* and *D* grounded to end ring. Fig. 4—Coil *B* grounded to the core at *X*.

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coil, back to segment *A* and through the defect as indicated by the arrows.

If two segments located at different points on the commutator were to become grounded—for example, segments *A* and *D*, Fig. 3—then coils *B*, *C* and *D* would be short-circuited, the closed circuit through them being that indicated by the arrows. Should these grounds be of low resistance, such as metal-to-metal contact between the segments and metal end ring, they would produce the same results as when a group of coils is short-circuited; namely, make the machine operate as though it were heavily loaded and the coils heat up to a dangerous temperature in a very short time.

In many cases the grounds occur in the coils themselves. One of the most common places for the insulation to fail is at the corners where the coils bend around the end of the core teeth, such as at *X*, Fig. 4. With only one conductor in the coil grounded and the power system free of grounds, the operation of the machine will not be interfered with. Or if the power system were grounded, but the frame of the machine having the grounded coil insulated, no trouble would be experienced in the operation. Before a ground on one turn in an armature coil could cause any trouble, the power system would have to be grounded at some point and the frame of the machine containing the faulty coil grounded. Frequently, when such faults do occur, the rush of current through the defect is sufficient to cause a severe arc and seriously injure the coil before the safety device can open and disconnect the defective machine.

The failure of the insulation to ground at the corner of the slot may be due to a number of causes. In forming the coil the straight sides that go in the slots may not have been long enough and as a result the coils bind on the corners of the teeth. This is hard on the insulation at the corners of the coils; at the bends of the coils where they come out of the slots is also one of the weakest points in the insulation, since it is difficult to get the tape to lie as smoothly on these parts as on the straight parts of the coil. Therefore any additional mechanical strain placed on these sections is likely to cause trouble. Sometimes it occurs that a coil or coils are not held tightly in the slots; this allows them to vibrate when the machine is in operation and eventually destroy the insulation. Even though they are held tightly in the slots, it is almost impossible to prevent some slight movement of the coil ends. As the insulation dries out and becomes brittle, fine cracks are formed into which carbon dust and moisture may penetrate and cause leakage paths from the core to the conductors in the coils. At first these current leaks are small, but they gradually carbonize the insulation and in time cause a failure to ground or short-circuit two or more turns in the coil.

In industries where large quantities of graphite are used, it frequently happens that coils are found in armatures with the insulation at the slot corners completely destroyed. One of the best remedies for this is to take the motor out of service about every three months, give the winding a thorough cleaning and then paint it with a good insulating varnish.

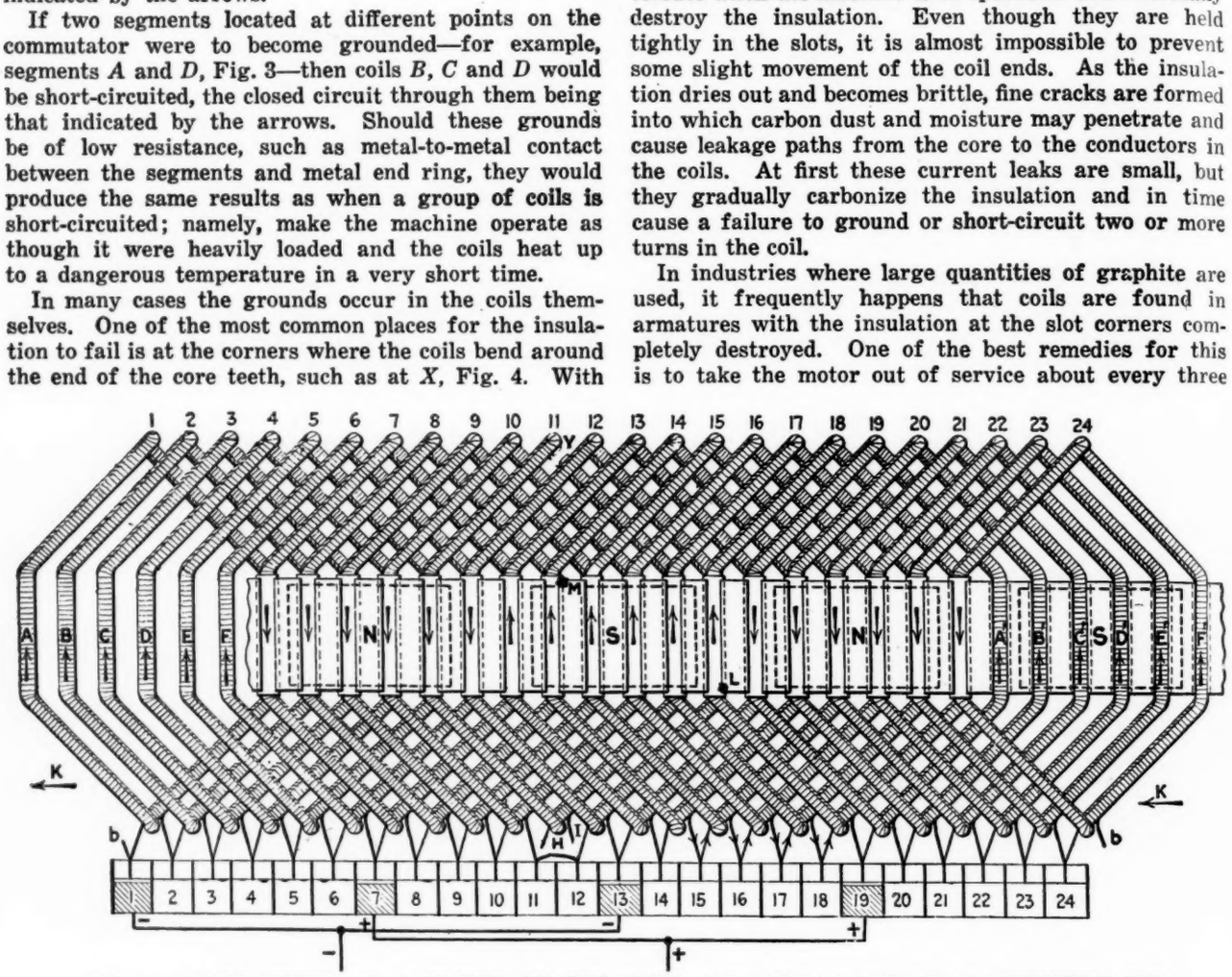


FIG. 5. SHOWS EFFECT OF A GROUND ON TWO COILS AND HOW TO CUT OUT A DEFECTIVE COIL

When a motor is started and stopped frequently, as in crane and elevator service, it sometimes happens that, due to the control equipment getting out of adjustment, the shunt-field circuit is open with no means provided to take care of the discharge from this circuit. Under such conditions the field winding acts as an induction coil and produces a very high voltage that may break down the armature insulation to ground.

In a machine the frame of which is insulated from ground, if two or more turns become grounded in the same coil it would have the same effect as if these turns were short-circuited; that is, it would cause heating of the coil, which would destroy the insulation in a very short period. A ground on two different coils in the winding will short-circuit a group of coils and will produce the same effect as if two segments in the commutator were grounded. In Fig. 5 a ground on the side of coil 14 at *M*, and a ground at *L* on coil 18 will form a closed circuit from *M* around through coil 14 to segment 15, then through coil 15 to segment 16, coil 16 to segment 17, coil 17 to segment 18, through part of coil 18 to *L* and then through the core back to *M*, thus completing the circuit for the coils. If the insulation of the two grounds is low, a large current will be set

up through this group of coils, which will act as a heavy overload on the machines and also cause excessive heating.

To locate a grounded coil in an armature winding with a test lamp requires that the armature winding be broken up into sections and each section tested. For example, in Fig. 6, assume coil 11 to be grounded at *X*. By placing one terminal of the test circuit on the armature shaft and the other on the commutator a light would be obtained from any one of the segments. The resistance of the winding is so low that the brilliancy of the lamp will not be affected no matter how many coils may be in series between the defect and the commutator segment to which the test lamp connects. To locate the faulty coil, first open the winding at two points on opposite sides of the commutator, as at segments 6 and 18, as in the figure. This breaks the winding up into two distinct parts, with no connection between them, after which test each part for grounds. In this case a light will be obtained from leads *B* and *C* to the armature core since coil 11 is included in the group of coils betwen these leads. If the test circuit is applied to leads *A* or *D* and the armature core, no light will be obtained, since all the coils in this group are clear of grounds. It is now known in which half of the winding the defect is located. The next step is to divide this section in half again and test each subdivision for grounds. For example, lift leads *E* and *F* from segment 12 and test from these leads to the core. This time it will be found that a light will be obtained from lead *E* but not from *F*, since the defective coil is in the group to which lead *E* connects. It will then be necessary to further subdivide the quarter that contains the defective winding and again test for the faulty coil until found. After the grounded coil has been located, it may be removed from the winding and reinsulated or replaced by a new one. On the other hand, the removal of the coil may not be desirable, and under such conditions it can be isolated from the rest of the winding.

In the event that there is only one ground on the coil, then by disconnecting both of this coil's leads from the commutator and replacing them by a jumper, the fault will be remedied. For example, we assumed that coil 11 was defective; by disconnecting leads *H* and *I*, Fig. 5, and connecting segments 11 and 12 together, the faulty coil will be cut out of circuit and the opening in the winding closed by the jumper, as shown. The leads of the faulty coil are now insulated and bound down with the leads from the other coils. When there is only one conductor ground in the coil, the machine may be put back into service and will operate satisfactorily. However, if two or more turns of the coil are grounded, they will form a closed circuit. Since the coil has voltage generated in it the same as the other coils in winding, a heavy current will be caused to circulate in the closed circuit provided by the defects. This current will generally be of a value that will cause the coil to heat to an extent that will destroy the insulation in a very short time and may also destroy the insulation of other coils in the same slots as the faulty one. In such a case, the short-circuit current can be eliminated by cutting the defective coil in two at the back end of the armature as at *Y*, Fig. 5. This opens the circuit through all turns in the coil, and although voltage is generated in the conductors, no current can circulate. Unless the winding is banded well out to the ends, it will be good practice to tie the ends of the defective coil to the others, to prevent them moving when the machine is in operation.

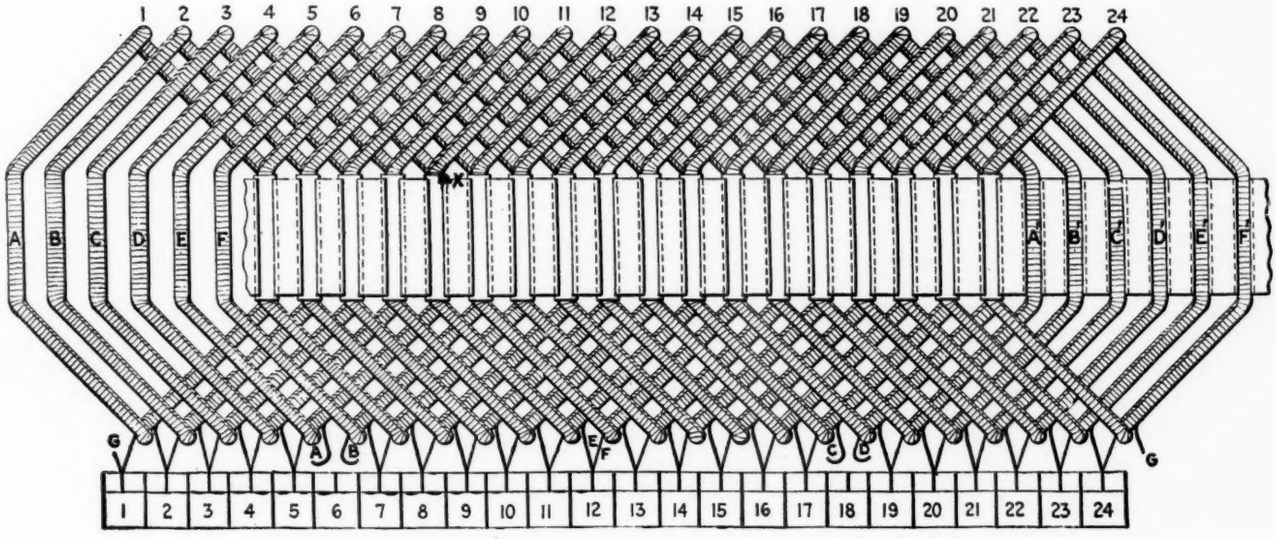


FIG. 6. HOW TO TEST WITH LAMP FOR GROUNDED COIL

Whenever there are two or more turns grounded in the same coil, it will be manifested by heating the same as for a short-circuit. When only one turn is grounded in a coil or one segment grounded in the commutator, it may be possible to insulate easily the frame of the machine when operating on a grounded power system. For example, if the machine is mounted on a wooden foundation and the frame is grounded through the conduit system, by insulating the end of the conduit from the machine, operation can be continued without further trouble from the fault in the winding.

There is a method of locating grounds in an armature winding with a low-reading voltmeter or telephone receiver. This will be discussed in another article. With this method the faulty coil can be located without disconnecting any coils from the commutator. The next article will deal with the location of short-circuits in windings.

# Burning Blast-Furnace Gas Under Boilers

By GORDON FOX* and F. H. WILLCOX†

*Attention to design will net approximately double the quantity of steam available that is obtained under ordinary conditions. The gas burner, ignition, combustion chamber, baffling, and the draft losses through the boiler passes are discussed.*

In the table of typical data relating to the use of gas from a 600-ton furnace, in the article "Steam Power From Blast-Furnace Gas," Nov. 8 issue, there was shown surplus steam available for electric power amounting to 69,000 lb. per hour. Deducting the steam equivalent of the 800 kw. used at the furnace plant, or 12,800 lb. per hour, there is actually 56,200 lb. of surplus steam, which, with good boiler-house operation, would require 6,875 lb. of coal per hour to develop and a stoker and fan investment of at least $14,500.

In altogether too many blast-furnace boiler houses the corresponding figures for the values in the table are 38,000 cu.ft. of gas per minute available at the boilers, used at an over-all efficiency of 55 per cent. This gives a total of but 107,500 lb. of steam and but 29,200 lb. of actual surplus steam as compared to the 56,200 lb. given in the preceding paragraph. This 29,200 lb. is perhaps the nominal surplus ordinarily realized. It is clear that some attention to burner and boiler settings, design, baffle installation, combustion volume and control apparatus will net approximately double the quantity of steam, save approximately 1,200 tons of coal per month, or generate an additional 1,720 kilowatts.

## Gas-Flame Production is Slow

With blast-furnace gas flame propagation is slow, so that the circulation of the gas streams, both in the burner and in the combination chamber, must be subjected to control. In the first place, contrary to the general opinion, it is not easy to mix completely and thoroughly furnace gas and air in the short confines of the conventional design of premixing and aspirating gas burner. Where air and gas are led into the burner by means of broad rectangular nozzles and the air admitted by ports above and below the jet of gas, a stratified mixture of gas and air emerges into the combustion chamber, and combustion extends into the second or even third pass of the boiler. Consequently, high flame temperature cannot develop, and as for those surfaces exposed to the flame, the transmission is chiefly due to radiation. As this varies as some power of the temperature difference, the amount of heat taken from the gases into the boiler is relatively small.

Actually, in many cases boilers using blast-furnace gas are acting as poor waste-heat boilers. A good share of the heat transferred into the water is literally worked out of the gas by convection, and at the low velocities convection transfer is poor. Usually, stack temperatures have been needlessly higher with blast-furnace gas firing than with even indifferent coal firing. Therefore, first of all, there must be provided a gas burner that positively effects a complete mixture of gas and air before these two components emerge into the combustion chamber. Moreover, the design of the burner has to be one that has gone through enough development so that the gas and air nozzles are sufficiently correct to enable a good carbureting mixture of air and gas to be maintained over the range of pressure that experience has taught will be encountered. The diversity factor at a plant having two furnaces gives a comparatively narrow range of pressure for about 1,400 minutes of the day; the other 40 minutes is the casting period and little or no gas is available from the furnaces. At a single furnace plant design cannot cope with variations in gas pressure, and to realize the potential power in a variable flow of gas, close hand regulation is necessary, or, very much better, positively and automatically regulated gas pressure may be employed at the stoves and positively and automatically regulated air admission at the boiler burners, the amount of air admitted being governed by the gas-main pressure.

## Essentials to Obtain Good Combustion

Having secured, by a proper design of burner, an intimately mixed gas and air supply into the combustion chamber, it is essential for best results, not only to have ample volume, but also to force impingement of the air-gas stream upon incandescent brickwork. The latter must be effected with as much celerity as possible after the mixture leaves the burner. Such contact builds up more quickly a maximum flame temperature by mechanically tumbling up and bringing into contact comparatively large groups of combustible molecules, with similar groups of oxygen.

Looking at it in another way, in spite of good mixing in a burner, the retention period of gas and air is too small in a burner to disperse the gas and air so that one molecule of carbon monoxide is enveloped by a skin of oxygen. Relatively, and for quick combustion of a lean gas, the fuel is in enormously large molecular aggregations. The better an ideal gaseous fuel can be mixed with air, the higher the temperature of combustion, because burning is completed in a space that approaches the infinitely small, the more a molecular state of division is approached.

## Transfer of Heat to the Boiler

The higher temperatures attained by better mixtures and combustion of the gas and air are perhaps more definitely helpful for the blast-furnace gas-fired boilers than for the coal-fired boiler. Under the best of circumstances relatively low temperatures are being dealt with, and the higher they can be made the better the transfer of heat energy to the boiler. Radiation of heat energy from the combustion chamber to the first bank of tubes becomes nearly three times better simply by raising the temperature of the combustion chamber from 1,900 to 2,300 deg. F. The increase in temperature which so materially betters the performance of the blast-furnace gas-fired boiler by a good radiation factor, further helps by causing heat transfer by conduction to assume more importance. Conveyance by conduction is due to the impact of molecule upon

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†Secretary, Freyn, Brassert & Co., Chicago, Ill.

molecule handing on the heat energy. Finally, by the higher temperatures the amount of evaporation obtained by convection is bettered on account of the circulation of groups of more highly heated molecules, carrying the heat from the combustion chamber to the boiler.

### Burning Gas and Solid Fuels

Having, by means of good burners and arrangement of combustion-chamber surface, attained the best possible mixing of air and gas and proper ignition, the furnace volume of combustion space must be made large enough so that the gases will be burned completely before the tubes are reached. Only the incandescent gases of combustion should come into play, for if the gases continue burning when the sweep of travel brings them into touch with the cold surface, then lingering combustion inevitably takes place, and the stack temperature increases. Or to put this fact in a different light, if the necessary combustion volume, premixing and quick ignition requisites are provided, the heating surface of the boiler can be more limited and still do much better work than a boiler of greater heating surface, but with inadequate burners and a small combustion chamber. Also there is little loss in efficiency with increasing rates of evaporation. One point commonly overlooked is that there should be no opening of coal-firing doors in a gas combustion chamber to chill the incandescent brickwork and the boiler itself and to dilute the gases of combustion.

One principle the writers believe to have been demonstrated and proved is, that any attempt to burn blast-furnace or other gases in combination with and in the same combustion chamber with solid fuels, is unsound in theory and inefficient in practice. Under the best of circumstances, when solid fuel is burned, there are an infinite number of unconsumed carbonaceous particles in the gases of combustion. These cannot be burned without a large amount of excess air. With certain percentages of $CO_2$, $O_2$ and C in the gases, an equilibrium obtains at various temperatures. As soon, however, as large amounts of a more concentrated $CO_2$ containing gas, such as burned blast-furnace gas, is introduced, there obtains a reaction whereby the solid C particles react with the $CO_2$ gas to form CO. This can be corrected only with additional excess air and lowering of temperatures of combustion.

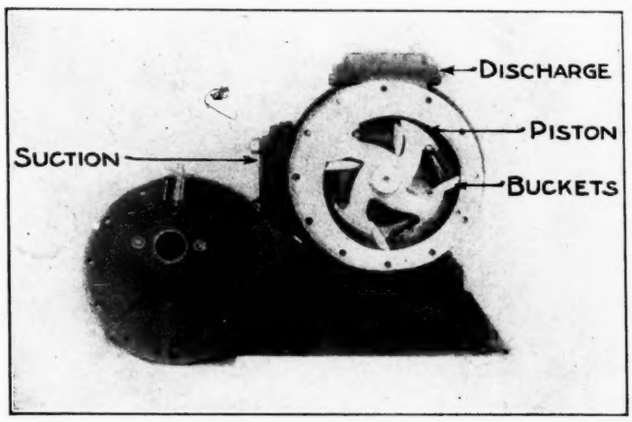
### Minimizing Non-Active Heating Surface

There remains but one essential point, and this is perhaps more important with blast-furnace gas-fired boilers than with coal-fired boilers, because we are dealing with gases of lower temperature from which all heat possible to economically extract must be removed. The point is to minimize to as great an extent as possible the non-active areas of the heating surface of the boiler, due to eddies occurring in the flow of the gases. It has been found that a high draft at the breeching, making possible high velocity of gas flow through a large number of passes of relatively small area, works to especial advantage for blast-furnace gases. Drafts that can be obtained by economically feasible stacks are not so high as to cause too fast a passage of gases and too short a retention period in the boiler. Of course, a certain amount of caution has to be observed in arranging the baffling so as to avoid draft losses that are of no use in effecting uniform velocities or absence of dead spaces. There is a certain amount of draft loss in making the turn from one baffle pass to the next. This may easily amount to more than one-half of the draft loss through the boiler, and it is of small use. The draft loss through the boiler should and can be such that two-thirds of the loss is frictional past and along the tubes, and but one-third is consumed in turns. This gives a minimum of dead eddy spaces in proximity to tubes, a reasonably high velocity of the gases of combustion and good reduction of stack temperature on loads anywhere between 30 and 100 per cent overrating.

Possibly the reader will surmise that a boiler for the economical utilization of blast-furnace gas is a composite of some of the principles applied to a stoker-fired boiler together with those applied to a waste-heat boiler. The development of the design, however, inclusive of the gas burner, the ignition, the combustion chamber, the baffling and the draft loss has been the work of several years and the conservative application of indicated advances and changes over a large number of installations.

## Blackmer Rotary Pump

An interesting and peculiar design of rotary pump is shown by the illustration. It is mounted on a self-contained base and may be either motor or otherwise driven. It consists of a cylinder, revolving piston and four buckets. The buckets drop into an extension chamber, as shown at the lower left, and pass to the right, drawing liquid in at the suction and pushing it out of the discharge at the top.




ROTARY PUMP WITH COVER REMOVED

As the piston revolves with the shaft, centrifugal force and gravity cause the buckets to be held against the cylinder, and air being exhausted from the suction line, the liquid comes in and fills the extension chamber of the pump, and is forced out of the discharge. It cannot carry by the discharge port, the only liquid that is carried by being that which fills the recesses in the piston, and this acts as a liquid packing and keeps the suction tight.

This pump is manufactured by the Blackmer Rotary Pump Co., Petoskey, Mich.

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Cleanliness in a battery room will minimize the danger of impurities getting into the cells. If there is excessive dampness present, it is possible for the electrolyte to absorb enough moisture from the air to overflow the cells, therefore the room should be kept dry.

# The Augsburg Ten-Cylinder Four-Stroke-Cycle U-Boat Diesel Engine

By JOHN L. BOGERT

DURING the late war many advances were made in Diesel-engine design. Most striking of the many new engines is the Augsburg submarine Diesel used on the German U-boats. To appreciate properly this product of the genius of Imanuel Lauster, for many years the chief engineer of the Augsburg works, it is necessary to keep constantly in mind the exacting conditions he was obliged to fulfill. The available space in a submarine is strictly limited as to height and width—length alone is available, and even in that dimension not an inch must be wasted.

Any intelligent critic of these 3,000-b.hp. Diesel engines should keep constantly in mind the exacting requirements of the problem, which called for the greatest possible power combined with the least possible weight and the smallest possible space. The least possible weight meant steel construction in places where cast iron is ordinarily used, high speed and short stroke. Prior to the war Herr Lauster had designed a six-cylinder four-stroke-cycle 1,200-b.hp. U-boat Diesel engine with cylinder bore and stroke of 17.7 in. each, and the wonderful work done by this engine undoubtedly prompted the German navy to turn definitely and finally from the two-stroke-cycle to the four-stroke-cycle engine in submarine construction. In the natural sequence of development, after the 1,200-hp. came the 1,750-hp. Diesel with cylinders 20.86 in. in bore and stroke. When, however, the demand was for yet more power, even up to 3,000 b.hp. on each shaft, to make possible higher speed, it was felt desirable to use more than six cylinders rather than increase the cylinder dimensions. Experience had shown that as much as 300 hp. might be obtained from a 20.86-in. cylinder.

To appreciate properly just what that means, we cannot do better than compare these Augsburg engines with the engines of the famous motorships "Selandia," "Jutlandia" and "Christian X." These three motorships have eight-cylinder four-stroke-cycle Diesel engines with pistons of the same diameter as those of the ten-cylinder four-stroke-cycle 3,000-b.hp. Augsburg U-boat engines. Augsburg, however, gets 300 hp. out of a piston 20.866 in. in diameter, while Burmeister & Wains are content to get 131 hp. from a piston of the same size. Technically, this can mean but one thing—more than twice as much oil must be burned in a given time in the Augsburg cylinders as in those of the Burmeister & Wains engine. That means vastly increased heat strains. Excessive heat strains had wrecked two-stroke-cycle Diesel engines in the past; how was a four-stroke-cycle engine going to overcome this difficulty? The answer is embodied in the Augsburg engine. Here are better materials, skillfully proportioned and disposed; water cooling and oil cooling of the most efficient character; forced lubrication that leaves nothing to be desired. Long ago Sir Dugald Clerk discovered that jacket-cooling losses and exhaust losses are largely complementary. There is always about the same amount of heat turned into useful work, and the rest goes into the jacket water or into the exhaust. If the jacket loss is reduced, more waste heat passes out in the exhaust, and vice versa. In other words, burning twice as much oil in a cylinder in any given interval of time means taking care of twice as much waste heat. Twice as much heat passing into the cooling water or cooling oil means much greater heat strains in the containing walls. This condition can be met only by the use of thinner walls or walls of a material having superior heat-conduction characteristics. A combination of both is evidenced in the construction of the Augsburg engine. The Diesel engine but follows along the

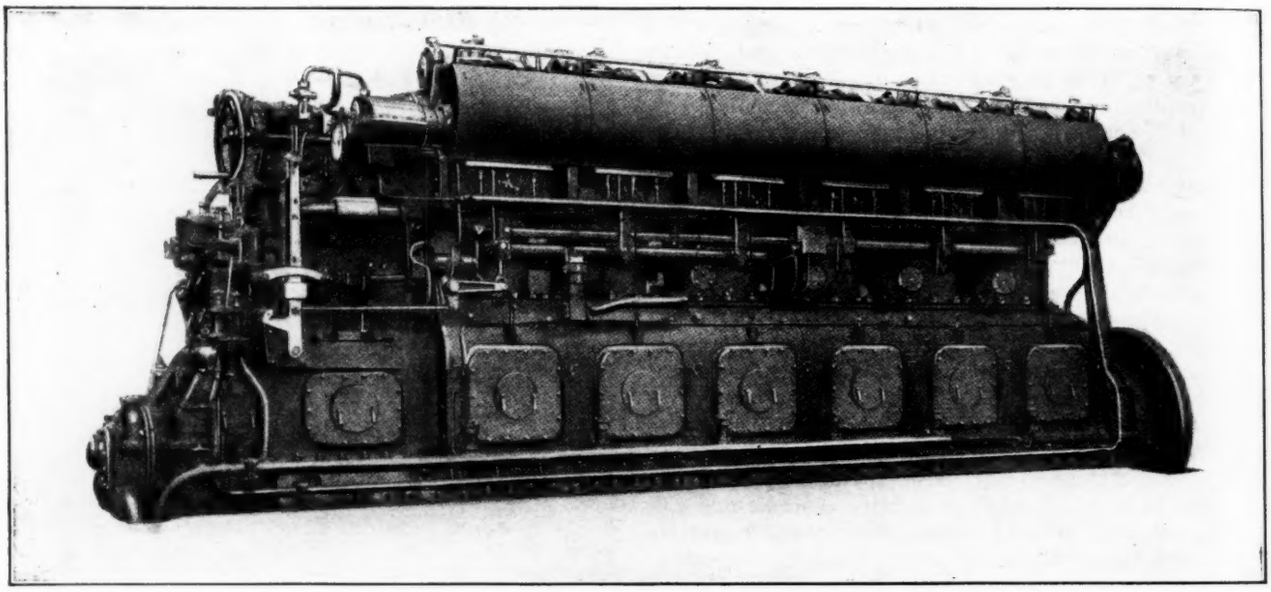

FIG. 1. AUGSBURG 3,000-HP. HIGH-SPEED DIESEL

same lines that were traveled by the steam boiler in its development. Very early in the history of steam engineering it was discovered that cast iron made a poor furnace material, and even the thickness of steel must be kept down below § in. if a white-hot fire is on one side and water on the other. Comparatively thin wall boiler tubes can stand the application of an amount of heat that would wreck the thicker boiler plate under

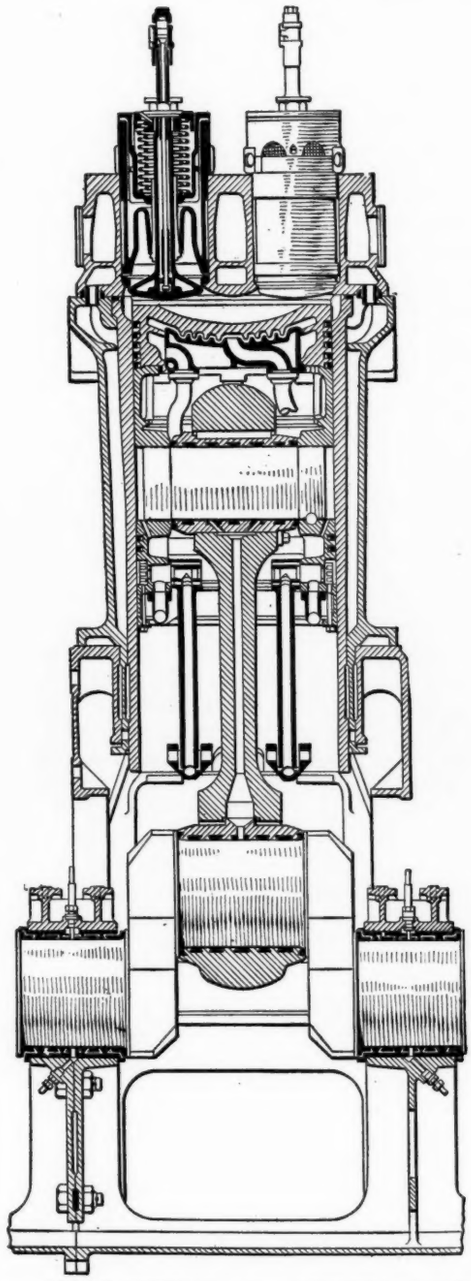

FIG. 2. CROSS-SECTION OF AUGSBURG CYLINDER

the same conditions. Hence, we find the piston heads, cylinder heads and walls of the Augsburg engine less than half the thickness of those of the Burmeister & Wains engines with cylinders of the same bore.

At their designed speed of 140 r.p.m. the mean piston speed of the Burmeister & Wains engines is but 672 ft. per min.; the Augsburg engine at 390 r.p.m., which is marked on its name-plate as its designed speed, has a mean piston speed of 1,356 ft. per min., or twice as much as that of the "Selandia." Moreover, at sea the Burmeister & Wains engines regularly turn but about 127 r.p.m.

Again, the mean indicated pressure during the combined power and compression strokes of the Burmeister & Wains engine averages 90 lb. per sq.in.; in fact, these engines were designed for this pressure. The Augsburg engine at full rated power has mean effective pressures of between 120 and 130 lb. per square inch.

One other indication of how readily this Augsburg engine submits to overloading is furnished by the exhaust temperature when the engine is developing full power. When the switchboard indicates a development of 3,000 hp., the electrical-resistance pyrometer located in the exhaust pipe rarely records a temperature lower than 1,000 deg. F. Of course the temperature at the exhaust valves and exhaust-valve cages is much higher than that, and were they not thoroughly water-cooled they would most certainly warp and give trouble. The exhaust temperature of the usual slow-speed Diesel seldom exceeds 700 deg. F., and in actual service is often nearer 600 degrees.

Special emphasis has been given to these characteristics of the Augsburg U-boat Diesel engine in order that engineers may appreciate the fact that it represents a distinct advance in the art of Diesel-engine design and construction. This is peculiarly true in the matter of cylinder-head, piston-head and exhaust-valve construction. An overload capacity of 20 per cent was formerly considered all that any Diesel-engine should be asked to carry. Any attempt to overload a Burmeister & Wains engine in the way this submarine engine would be overloaded when chasing or fleeing from an enemy ship would simply be disastrous. Here is an engine that can be overloaded 100 per cent without serious injury. That indicates that it contains the germ of the future high-speed engine. The successful way in which it carries excessive heat strain, excessive pressure and excessive piston speed is a credit to the builders and a monument to the designer.

The weight of this ten-cylinder engine is given by the makers as 168,000 lb. That figures out 56 lb. per b.hp. at a 3,000-b.hp. rating and 84 lb. per b.hp. at a 2,000-b.hp. rating.

It is the opinion of many engineers, after careful observation of this engine in operation and prolonged study of its details, that it might be easily run to develop 2,000 b.hp. for days and weeks continuously without suffering from undue wear of any part.

There is no doubt that a wonderful Diesel engine might be constructed, using the same valves, valve gearing, cylinder heads, piston heads, and having the same bore but a longer stroke, and a slightly longer connecting rod to crank ratio. The demand, both in stationary and marine fields is for an engine of lighter weight and correspondingly lower first cost.

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Speaking of powdered coal, the Canadian Department of Mines voices the opinion that if the furnace is correctly designed about 3 B.t.u. per second may be liberated per cubic foot of combustion space. This rate of combustion is sometimes exceeded, but if very materially exceeded, the coal will not be burned completely.

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An unlined tunnel serving a 14,000-hp. hydro-electric plant at Herlandsfossen, Norway, has a static head of 450 ft. at the bottom, the highest head of any such tunnel in Europe, according to the *Engineer*.

# Power-Plant Accounts—XIV. Investment Account and Reserve for Depreciation and Obsolescence

By WILFRED A. MILLER

IN PAST discussions considerable stress has been laid upon the effects which depreciation and obsolescence have upon cost of power generation. It was established that they are recognized elements of cost in spite of being intangible. It was further shown that the costs incurred through these agencies were at the expense of the apparatus in the plant. That is, the intangible nature of the cost lay in the fact that we did not pay for it in money, but, without any action on our part, paid for it in apparatus through the gradual wearing away thereof. The condition presents a situation that, as yet, has not been taken care of in our accounts. True, we have been careful to take account of the presence of depreciation and obsolescence among our costs by including them as items in our Indirect Expenses account in the ledger, but we have made no provision for reducing the value of our equipment by the amount of such depreciation and obsolescence. This brings to the fore an account with which we have so far had little to do; namely, the Investment account. Originally, this account was introduced in order that we might have some place in which to make entries that recorded the purchase of new equipment of any kind, since such transactions were entirely different from expenses and were, in fact, investments.

This is the fourteenth of a series of articles written in conversational style and treating the subject of power-plant accounts in a thorough, yet simple manner. They were prepared primarily for the guidance of the operating engineer who wishes to keep track of the cost of the power he is making, but who knows nothing at all about bookkeeping. Others may find the articles helpful in clearing up their ideas on the subject. This installment starts by reviewing part of what has gone before and then shows how the Investment account, together with an account called Reserve for Depreciation and Obsolescence, can be made to show the total money invested in the plant and also the present value of the plant.

It is now time to widen the scope of the Investment account and see to it that it has entered in it all items that rightfully belong there. As its name implies, the purpose of this account is to record the amount of investment which the power plant represents. This being the case, it is only proper that it should contain the whole value.

At present the investment account does not contain this, owing to the fact that we have made in it only entries of purchases contracted for subsequent to the time at which we opened our books. Consequently, the great bulk of the power-plant value does not appear in it at all. In order that the Investment account shall have any real significance, it is necessary that this missing value be entered in it. The amount involved in this entry can readily be determined from the inventory which was taken for the purpose of arriving at the proper charge to be made for depreciation. It will be remembered that this inventory provided for making a record of the original cost of all equipment of whatsoever kind and also of its value at the time of the inventory. The natural thing to do, therefore, would seem to be to take the present value and use its amount as the basis of the entry to be made in the Investment account, doing so, of course, through the medium of a journal entry. We shall follow this suggestion for the present, although later we may decide that a modification of it is preferable.

After having entered the current inventory value in the Investment account, we might expect that the total of the account would at all times reveal the net value of the equipment, since we keep adding to it the value of such purchases as are made from time to time. But how about depreciation and obsolescence? Have they any bearing on the question? If we stop to think a moment, we will realize that they have, and a very important one at that. As already shown, depreciation as well as obsolescence operates to reduce the value of the equipment. This being so, we would of course have to take them into consideration when valuing our plant. For example, when we start keeping our books, let us say that we find that the inventory we have taken sums up to a current value of $100,000 and that during the year purchases are made in the amount of $10,000. Then at the end of the year our Investment account would show a balance of $100,000 + $10,000 = $110,000. This, however, is not what the equipment is worth, because we have not made any allowance for depreciation or obsolescence. If we assume that the amount included for them in our indirect expenses added up to $3,000, it is evident that our equipment is worth only $110,000 — $3,000 = $107,000 at the end of the year. Hence, if our Investment account is to show the facts, its balance at the end of the year must be only $107,000. That is, the $3,000 depreciation and obsolescence must be subtracted from it.

How shall we perform this subtraction? We naturally resort to a journal entry for the purpose, and its form must therefore be decided upon. We know that we never make subtractions in our ledger accounts. Having two sides to every such account—the debit and credit—we can make an entry which is the equivalent of a subtraction without performing that operation in the account. Thus, if we have a certain amount in the debit side of an account and wish to reduce it for any reason, we have only to make an entry in the credit side of the amount by which we desire to reduce it, in order to accomplish our purpose. This, therefore, is the course we pursue when we wish to deduct the amount of the depreciation and obsolescence from the Investment account. Since the entries of the original value and subsequent purchases were all necessarily debit entries, it follows that in order to make a deduction from the account the entry made for that purpose must be a credit one. Thus, in the case of the example

just used for illustrative purposes, the journal entry would appear as in Fig. 1.

The fact that every charge made to indirect expense for depreciation or obsolescence is at the expense of some of the equipment value contained in the Investment account opens up a convenient means of recording both facts at the same time. Instead of making a journal entry for a depreciation or obsolescence expense charge at one time and then removing that amount from the Investment account through a journal entry at some other time, we can make both entries at the same time, which procedure has the advantage that we assure ourselves that we have not forgotten to reduce the Investment account balance by the amount of the depreciation and obsolescence. To show just what is meant, Fig. 2 illustrates two coupled entries as they would appear in the case of the example used for Fig. 1.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Dec. | 31 | Investment | Depreciation | | 3000 | — |

FIG. 1. JOURNAL ENTRY TO CREDIT DEPRECIATION DIRECTLY TO INVESTMENT ACCOUNT

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Dec. | 31 | Indirect Expenses | Depreciation | 3000 | — | |
| | | 31 | Investment | Depreciation | | 3000 | — |

FIG. 2. JOURNAL ENTRY OF FIG. 1 PUT NEXT TO CORRESPONDING DEBIT TO INDIRECT EXPENSE ACCOUNT

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Dec. | 31 | Indirect Expenses | Depreciation | 3000 | — | |
| | Dec. | 31 | Reserve for Depreciation and Obsolescence | Depreciation | | 3000 | — |

FIG. 3. SAME AS FIG. 2, BUT WITH SECOND ITEM CREDITED TO RESERVE ACCOUNT

To deduct the amount of depreciation and obsolescence from the Investment account is a perfectly legitimate procedure, but it has a rather serious drawback, which is that through this method a distorted impression is likely to be given by the balance remaining in the Investment account. While we ourselves will perhaps not be misled by the condition of the account because of our intimate knowledge of the situation, a stranger might receive an entirely erroneous impression of the facts. For example, it is conceivable that in the course of time depreciation may have reduced the book value of our plant to 50 per cent of what it was to start with. To one unacquainted with the full significance of the figures there would be conveyed the impression that the plant must be much smaller than it really is because it has so low a value. Another objection to the method is that no readily accessible record exists of the amount of depreciation and obsolescence that has been written off. It is often valuable to have this figure for convenient reference and to show that the amount written off is a conservative one; that is, that the rates used have been neither too small nor too great.

To meet the foregoing criticisms, it is usual to provide a separate account or accounts in which to keep track of the reduction in investment value due to depreciation and obsolescence, rather than to make this reduction directly in the Investment account itself. Such accounts are generally known as reserve accounts, although a more accurate designation is to call them valuation or allowance accounts. However, the term reserve is used so commonly in this connection that it will do no harm for us to employ it. The way in which such a reserve account works is this: When we want to "write off" from our investment value the amount of the depreciation and obsolescence that we have charged to the Indirect Expenses account, we credit the amount to the reserve account instead of to the Investment account. When we want to get at the true value of our equipment, we must make use of both the Investment account and the reserve account. By subtracting the amount in the latter from that in the former the actual net value of the plant is secured, while at the same time we have before us the original value and the amount of depreciation and obsolescence. Thus, we can readily compare one with the other to form an idea of how large a part depreciation and obsolescence have played in the reduction of the initial value.

To show just how we are to apply this scheme to our bookkeeping, let us first settle on a name for the reserve account. Let us decide to call it the Reserve for Depreciation and Obsolescence account, since that describes its purpose. Our next step is to open such an account on a blank page of our ledger and to make the appropriate memorandum of the account and its page number in the index on the first page of the ledger. Now, whenever we come across an entry to be made for depreciation or obsolescence, we will debit its amount to Indirect Expense as before, but make the corresponding credit to Reserve for Depreciation and Obsolescence, instead of to Investment. Such a coupled entry is shown in Fig. 3.

What we have really done in the foregoing is to divide the account that contains the equipment value into two parts, the debit side of which we have called Investment account and the credit side of which has become the Reserve for Depreciation and Obsolescence account. Therefore, when we wish to determine the true equipment value, we must always be sure to combine these two accounts and take their balance, just as we would find the balance of the Investment account alone if the credit entries were made to it instead of to the reserve account.

INVESTMENT

| DATE | EXPLANATION | REF. | AMOUNT | DATE | EXPLANATION | REF. | AMOUNT |
|---|---|---|---|---|---|---|---|
| 1921 Jan. 15 | Flow meter equip | | 1000 — | | | | |

FIG. 4. INVESTMENT ACCOUNT AS IT HAS BEEN KEPT

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1921 June | 30 | Reserve for Depreciation and Obsolescence | Depreciation and Obsolescence charged to Indirect Expenses | | | 2000 — |
| | | 30 | Investment | New value of equipment as determined by Inventory | 70000 | — | |
| | | 30 | Reserve for Depreciation and Obsolescence | Depreciation on Equipment up to time of Inventory | | | 8000 — |

FIG. 5. JOURNAL ENTRIES TO MAKE INVESTMENT AND RESERVE ACCOUNTS COMPLETE

In line with the plans laid down, it will be necessary for us to make the additions to our ledger accounts, discussed in the foregoing, before we can call it complete. That is, we must first of all enter in the Investment account the value of the equipment as revealed by the inventory, and in the second place we

must open a reserve account and enter in it all the necessary records to date. At the beginning of the present discussion we decided to enter in the Investment account the value of the equipment at the time of the inventory, although attention was called to the fact that we might be able to evolve a more satisfactory way of completing the record. We are now in a position to appreciate what was had in view at the time; namely, that instead of entering the inventory value, we had better enter the new value in the Investment account and then enter the depreciation and obsolescence in the Reserve for Depreciation and Obsolescence account. The value so to be entered would obviously be the difference between the value when new and the value at the time of inventory. Some errors might creep in here, due to the fact that it may have been impossible to arrive at a value when new of some of the apparatus. In the case of such items it became necessary to use an appraised present value, omitting the new value. Therefore, before taking the difference between the total new and present values, it would be necessary to make allowances for those new values that were missing. This might be done by inserting for them the present value, although a better method would be to estimate the new value on the basis of the present value and use this in making up the total new value. While some discrepancies would doubtless be introduced by this method, they would be so small in extent as to make it a matter of negligible importance.

So far as the Reserve for Depreciation and Obsolescence account is concerned, two factors must be looked out for. The first we have already met; namely, the difference between the adjusted new value and the inventory value, which is to be entered in the reserve account. The second factor consists of whatever items of depreciation or obsolescence have been charged into the Indirect Expenses account since we started our bookkeeping. If there have been any of these, as there most likely have been every month, we will have to go through the Indirect Expenses account carefully and make a list of all such items and add them up. The

INVESTMENT

| DATE | EXPLANATION | REF. | AMOUNT | DATE | EXPLANATION | REF. | AMOUNT |
|---|---|---|---|---|---|---|---|
| 1921 Jan. 15 | Flow meter equip. | | 1000 — | | | | |
| June 30 | Original equip. | | 70000 — | | | | |

FIG. 6. INVESTMENT ACCOUNT WITH VALUE OF ORIGINAL EQUIPMENT INCLUDED

total so arrived at will then have to be entered in the reserve account.

To illustrate the steps through which we should actually have to go to bring our ledger into the shape we wish, let us make the following assumptions: Equipment bought since books were started, $1,000; total depreciation and obsolescence charged to Indirect Expenses since books were started, $2,000; new value of equipment, as far as obtainable, $60,000; estimated new value of equipment other than the above, $10,000; inventory value of equipment, $62,000.

According to the way in which we have kept out accounts up to the present time, the Investment account would look something like Fig. 4 and there would be no Reserve for Depreciation and Obsolescence account at all. In order to bring the ledger into the shape in which we want it, it would be necessary to make the journal entries illustrated in Fig. 5 and post them to the ledger, first opening the new Reserve for Depreciation and Obsolescence account. The first entry takes

RESERVE FOR DEPRECIATION AND OBSOLESCENCE

| DATE | EXPLANATION | REF. | AMOUNT | DATE | EXPLANATION | REF. | AMOUNT |
|---|---|---|---|---|---|---|---|
| | | | | 1921 June 30 | Charges to operation | | 2000 — |
| | | | | 30 | Reserve set up | | 8000 — |

FIG. 7. RESERVE ACCOUNT INCLUDING REDUCTION IN VALUE BEFORE BOOKS WERE STARTED

care of the $2,000 worth of depreciation and obsolescence charged to the Indirect Expenses account since starting the books, by crediting this amount to the reserve account that we have just opened. The second entry adds the value of the equipment when new to the Investment account by the $70,000 debit to that account. This amount is arrived at by taking the sum of that part of the new value that was actually obtained and that part of it which had been estimated; namely, $60,000 and $10,000 respectively. The third entry writes off the depreciation that had occurred prior to the time of opening the books, by making an $8,000 credit to the Reserve for Depreciation and Obsolescence account. This amount is determined by finding the difference between the total new value and the value at inventory time; that is, $70,000 — $62,000 = $8,000. After the postings have been made, the Investment and Reserve accounts would have the appearance shown in Figs. 6 and 7, from which it is seen that the total investment amounts to $71,000, of which $10,000 has been written off for depreciation and obsolescence, thus bringing the net worth to $71,000 — $10,000 = $61,000 at the present time. The ledger now contains a full record of power-house valuation, which is as it should be. The one thing to remember in using the Investment account is that it should never be considered by itself, but should always be used in conjunction with the reserve account.

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A miscellaneous assortment of stones, bricks, corn cobs, etc., was found recently in the discharge pipe of a safety valve when the stack fell down and broke the pipe, according to the *Travelers Standard*. The possible dangers of a discharge pipe on a safety valve are well pointed out in this connection, and it is advised that care be taken to arrange the pipe so that objects such as were found in this one cannot be put into it, either from carelessness or mischief. Also, it is added, if any part of the discharge pipe runs vertically a small hole should be drilled at the lower end for the escape of condensation, which otherwise might freeze during the night in winter.

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As far as the coal is concerned, the formation of clinker depends on two main factors—the percentage of ash in the coal and the melting point of the ash.

# EDITORIALS

## Psychological Factors in Coal Production

COAL production has its ups and downs from many causes, not the least of which is the psychological factor which sometimes enters to increase or decrease buying above or below what would otherwise be normal. Examination of recent weekly coal reports from the United States Geological Survey gives splendid illustration of this type of influence as well as of the seasonal and business factors.

The present calendar year has witnessed the usual seasonal decrease in coal production during the spring months largely augmented by the depression in production caused by slack business. The usual gradual recovery from minimum production of early spring occurred, but the summer "normal" was distinctly below the summer period requirements of the four previous years, clearly demonstrating the slackness of business generally. As fall approached, there was the gradual further increase in demand reflected by production increases to about one and one-half million net tons per day on the first of October. Then came the threat of labor to interrupt production and transportation. The psychological factor at once dominated the situation. Demand increased to such an extent that output rose over twenty per cent within two weeks, reaching what would practically be normal for the fall season with a good business year. But promptly with the reassurance that labor on the railroads was not to interrupt transportation, as had been feared, came also the willingness again to decrease coal orders, and for the last month there has been a return to the low production averages of early fall.

There has never been more striking demonstration of the three important factors determining coal demand of the country. One of these remains wholly beyond control; namely, the factor of business conditions. No single coal user nor group of them, no matter how influential, can devise any scheme whereby normal requirements for fuel will be experienced when subnormal requirements for all other merchandise prevail. But the other two factors are more or less well within the range of user control.

To such extent as credit and facilities for coal storage permit, the uniform purchase of fuel over long periods will offset the evil consequences of seasonal periods of high demand or low demand. As has often been emphasized, it is the power-plant executive's responsibility to stabilize these requirements as fully as his resources make possible. However, it is even more his responsibility to offset the alarming and quite unnecessary peaks of demand resulting from psychological causes.

With a reasonable stock of coal on hand, there is no excuse for the purchaser who rushes into the market pell-mell with every rumor of interruption of supply or reported prospective increase in price. Nothing is so likely to result in unfavorable and unreasonable prices for coal to the user as just this practice. Competitive conditions among buyers of coal tempt the unreasonable dealer or producer to charge "all the traffic will bear." The conditions late in 1920 were the most convincing demonstration of this. The conditions of the past two months equally well demonstrate that the purchasers did not learn the lesson from the previous year. The price of coal produced by this sudden increase in demand was, fortunately, not anything like so high as the season before. Indeed, it would have been practically impossible, starting from low production to create such high prices within so short a period as that during which the peak demand prevailed. Nevertheless, he who aggravates such conditions must realize that some times, if not most times, he will pay unduly if he thus assists in the creation of a "bull market."

## What Pays Best?

CERTAIN old proverbs have been repeated for years with scarcely a soul to challenge their truth. An example is: "Anything worth doing at all is worth doing well." Another is this: "The best is cheapest in the end." These old saws are "near truths"; they are exaggerations designed to convert the man who is foolishly following the principles, "Anything that will get by is good enough" and "Buy the cheapest thing that will do the work." If a man must go by hard and fast rules, the first two are much safer than their opposites. Sometimes it takes one exaggeration to kill another.

Operating by proverbs is gradually going out of style, and they are being replaced by decisions based on sound judgment applied to each individual problem as it arises. The modern power-plant engineer does not often choose the cheapest nor always the best. He looks each situation over and decides what kind of a job is advisable for the work in hand or what price must be paid to get equipment that will be most suitable for the place where and the period for which it is to be used. In a power plant that is to be used for many years and is to operate at a high load factor, it is likely that the decision will call for high-priced equipment and the best possible workmanship throughout. For a temporary job or for equipment to be used intermittently or at a low load factor, it may be thought well to save in first cost by accepting something less than the "best." In other words, it all comes down to a question of weighing first cost against the advantages to be obtained.

Sometimes the facts of the case are so simple and so well known that nothing much is involved but a little arithmetic. Where the choice is between two pieces of apparatus of equal convenience, reliability, etc., and differing only in first cost, estimated life and gross yearly saving, there should be no difficulty in making the decision. The more desirable equipment is that in which the net yearly saving (the gross yearly saving minus the sum of interest, depreciation and operating cost) is greater.

The case just cited is exceptional in that the two pieces of equipment were equally convenient, reliable, etc. In practice this would rarely occur. However, it

is well, even in the more involved cases, to reduce everything possible to figures. On the basis of these figures alone, one piece of equipment will appear to be a better purchase than the other to the extent of a certain sum of money per year. If, then, the other piece of equipment is more reliable or more convenient, it may be possible to judge whether it is worth while to pay this sum for the extra convenience and reliability insurance.

## Do Metals Crystallize?

NOT many years ago it was commonly believed and stated that when a piece of metal failed on account of repeated vibration or bending, it was because the metal had crystallized. This theory has been discredited in recent times; a study of steel and other metals under the microscope shows that they are made up of crystals at all times. Nor has it been possible to discover any appreciable change in the structure of a metal subjected to repeated stress. There does, however, appear to be a breaking down of the crystals, as indicated by the formation of minute cracks or slipbands.

One of the latest theories is that the breaking of a metal due to fatigue is caused by the stress in some portion becoming greater than the strength, with the result that a rupture starts at that point and spreads a little each time the stresses are reversed. Whether this is true or not, it is a well-known fact that the character of the surface has a lot to do with the strength of parts that are subject to vibration or rotation under load. Not only is the strength greatly reduced if there are sharp corners or scratches of noticeable size on the surface—but there is even a difference between the strength of pieces with rough-turned and those with polished surfaces.

For years designers have felt a great need for some method of determining the safe limit of stress in the shafts or other portions of machines that are subjected to millions of reversals of stress on account of rotation or vibration. It now seems that this requirement will be filled by an extensive investigation that is in progress at the University of Illinois. Bulletin No. 124 of the Engineering Experiment Station, University of Illinois, has just been issued, and contains some most interesting and important conclusions obtained from the extensive series of tests that is now going on in its laboratories. These experiments, and the results so far obtained, are outlined on page 922 of this issue of *Power*. In this discussion it has only been possible to touch on the more important points, but enough is given to show the immense usefulness of this investigation to designers and manufacturers.

## Ventilating Electrical Machinery

THE heat developed in electrical equipment must be liberated as fast as produced, or the apparatus will soon reach a temperature where the insulation will be destroyed. With slow-speed engine-driven machines the problem has been a simple one. The dimensions of the machine per unit output are so large that the fan effect of the rotating element itself caused sufficient air circulation to effectively ventilate the machines. With the introduction of the turbine direct-driven machine, speeds increased from seventy-five or ninety to three thousand or thirty-six hundred revolutions per minute and the dimensions per unit output decreased inversely. Where the rotating element in the former was measured in feet, in the latter it was a matter of about the same number of inches. This high-speed compact design of the turbine unit practically made artificial ventilation of the machine a necessity.

The average turbo-generator will have passing through it every forty minutes a volume of air about equal in weight to that of the generator. Even though this large volume of air is washed, it is impossible to prevent dirt from getting into the windings, and past experience has shown that this created a fire hazard. The number of fires that have occurred in generators and the serious results from many of them both in this country and abroad have emphasized the necessity of preventing dirt from getting into windings with the ventilating air and also the development of some effective means of fighting the fire after it had once started. This has led to two distinct lines of development. One in this country was recently put into operation at the South Meadow Plant of the Hartford Electric Light Company, wherein a closed system of ventilation is used and the air is cooled by passing through a water spray and recirculated. The other is that coming into use in Europe, where the generator is water-cooled. The presence of water around a machine undoubtedly will make this system of cooling objectionable to many operating engineers. Where the air is recirculated, dirt is practically eliminated from the machine, and in case of a fire, extinguishing gas can be admitted, which could not be effectively done with the old system of ventilation, where the air was continuously taken from the outside. Many of the older-type machines have been equipped with steam or water connections for extinguishing fires, but the cure has proved to be about as bad as the disease.

Although this new system has not been in service long enough to demonstrate its effectivensss, it has much in its favor and undoubtedly will prove to be a means toward eliminating the objectionable features of the present system of generator ventilation.

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Secretary Wallace's recent recommendations that it will pay both farmers and people in country towns to use corn instead of coal for fuel in the districts where corn is cheap and coal is selling at high prices, is a reminder that some time in the far distant future we may obtain our fuel from agriculture. Burning corn is nothing new, for in certain districts it has been done at many times when the price warranted. This, however, has not reached any great proportions and has not been done in power plants except in rare cases in small installations. But this has a deeper meaning than the burning of corn; namely what adjustment must be made so that coal may be brought to the farmer at a price he can afford to pay and the corn to the consumer at a fair price to the farmer. Coal miners are working part time while the farmers burn corn.

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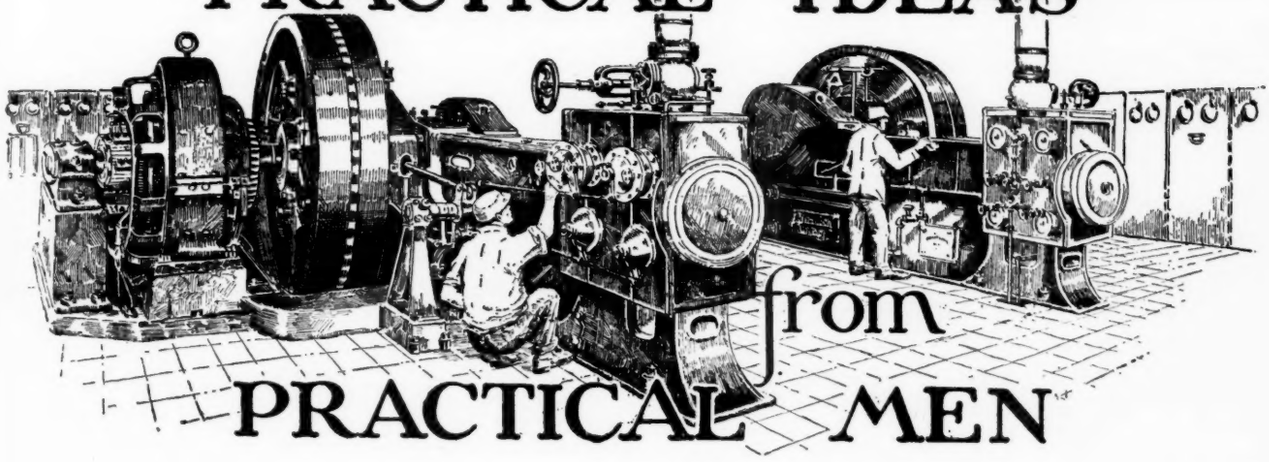
An employer who believes that he is getting the most out of his engineer by requiring him to be a general all-around man about the plant is making a mistake. An engineer's place is in the power plant, and not out in the factory repairing disabled machines and doing other numerous jobs, such as he will be called upon to do if he once starts. An engine should never be left unattended.

# PRACTICAL IDEAS from PRACTICAL MEN



## Cleaning Old Boiler Tubes

Many an old boiler needs a thorough overhauling and a good cleaning, but does not get it because the man in charge is afraid the tubes might be damaged in the process. Such hesitation is natural, but it may be disregarded if a proper method of cleaning is adopted and the operator will use his head and follow directions.

Scale removal is now a nice art. Modern mechanical cleaning methods have progressed a long distance from the days of the blunderbus and the boomerang type of cleaner. They no longer depend on violence but on exactness and rapidity—so much so, in fact, that they are widely used even in condenser and evaporator tubes, which are, as a rule, not over half the thickness of boiler tubes. The proper tool, rightly used, will not jar or disarrange the position, shape or structure of a boiler tube.

Years ago a revolutionary change occurred in the science of cleaning tubes of return-tubular boilers depending upon vibration produced by tapping the tube wall mechanically many times a minute. Ample vibration can be secured with a force of 2½ foot-ounces or less, so light a tap that it can be taken upon the bare hand without discomfort. Moreover, when the cleaning tool is kept in continual motion, as it should be, no two of its taps ever reach the same point on the tube's surface.

But how about the fact that leaks do sometimes develop when cleaning a boiler that has seen considerable service? If the cleaner did not cause the damage, what did? To catch the real culprit, it is necessary to understand exactly the tricks that scale plays.

Granted that scale plays havoc with boiler tubes—first, by preventing the free passage of heat, causing the necessity of bringing to bear a continuous excess of heat onto the metal of the tubes, burning them, changing the structure of the metal, doing the same thing that happens to a kettle when it is allowed to go dry; second, by holding the tubes in a vise-like grip, interfering with the normal elasticity of metal, causing the tubes to warp, buckle and, in the case of tubular boilers, to loosen from the header. The chemical reaction between scale and metal is not to be disregarded, especially when both are in combination with foreign agents.

Defects caused by scale are not always immediately evident. Why? Because scale itself covers up the leaks, solders the joints, acting as a cement. It is reasonable to suppose, however, that any extra strain is extremely likely to show up defects at inopportune moments. Thorough elimination of scale does show up leaks if they exist already, and that is the strongest reason for getting rid of scale without delay.

Leaks that are known can be repaired. Tubes can be re-rolled or replaced. The expense involved is small compared with that of waiting a few months or a year and then scrapping the boiler as junk. It is a satisfaction to know that the old boiler can be put in condition, that it can be continued in service for years if required, without waste of fuel or power and without fear regarding subsequent cleanings and further injuries.

Care should be taken that the method of cleaning is thorough. It is important to eliminate all the scale, especially from the tube ends. It is impossible physically to examine all the tubes of a boiler, particularly those on the inside where scale collects heaviest and which are at the same time least exposed to the direct force of every washing out. But the leading manufacturers of mechanical cleaners are willing to allow a trial of their cleaners before purchase. By accepting this privilege, it is a simple matter to determine the question of cleanliness of boiler tubes as well as the soundness of tubes that have seen considerable service.

The reward for scale-free boiler tubes is better work and more of it at greatly decreased cost. It is said that a human being is no older than his arteries. It can be said with even more truth that a boiler is no older than its tubes.

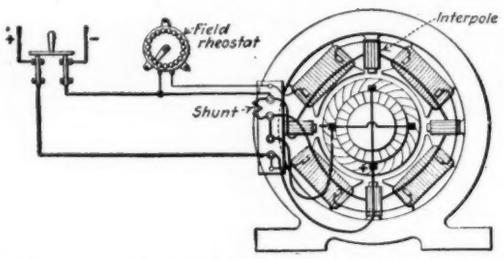
W. HARRIS DAY.

Buffalo, N. Y.

## Adjusting Interpole Field

Frequently, direct-current interpole machines are found in operation in which the interpole winding has too many turns and the strength of the field is adjusted by connecting a shunt across the winding terminals, as in the figure. This scheme works out satisfactorily where the load is fairly constant or where the changes in load are not sudden. If the load changes through wide ranges in short periods, the current will not divide in the proper proportions through the shunt and interpole winding, on account of the difference in inductance in the two circuits. Take the case of a sudden increase in load. The shunt, being non-inductive, offers practically no opposition to the flow of the current other

than its ohmic resistance. On the other hand, the interpole winding, being wound on an iron core, has a high inductance which tends to oppose any change of current through this winding. Consequently, with a sudden increase in load practically all the increase will flow through the shunt first and then gradually divide up with the interpole winding. This results in a period when the interpole flux is not sufficient to compensate




CONNECTION DIAGRAM FOR SHUNT INTERPOLE DIRECT-CURRENT GENERATOR

for the armature reaction and also furnish a commutating field; consequently, the machine is liable to spark at the commutator.

This was found to be the case on a generator supplying a load that fluctuated rapidly. After trying without avail various schemes to prevent this sparking, the shunt was taken off and a turn removed from each of the interpole coils. The machine still gave signs of sparking, and another turn was removed from each coil; this resulted in good commutation, and no further trouble has been experienced.

Boston, Mass. CHARLES A. ARMSTRONG.

## The Chief's Book Shelf

An extensive acquaintance with power plants in various parts of the world has convinced me that the chief engineer's bookshelf in the power-house is a fairly reliable index to the general efficiency of the plant. A man is what he thinks, and a man's thoughts are mainly influenced by his experience and by his reading. If we find a bookshelf containing a few out-of-date catalogs, a varied assortment of old nuts, samples of oil and packings and a thirty year old treatise on the steam engine, it is not to be expected that the chief will be a bright, enthusiastic engineer, with a wide grasp of scientific developments. He may be a good steady practical man within his limits, but it is almost a certainty that his range is narrow and that the subtleties of scientific operation are beyond him.

The ideal engineer's office bookshelf would contain a book of mathematical tables, a few modern catalogs, some well-known engineer's handbooks, and current numbers of the leading technical journals, with a special place for his own book of notes and clippings. If he can find room for a favorite classic, to remind him in times of worry and depression that this is a vast, beautiful world, so much the better.

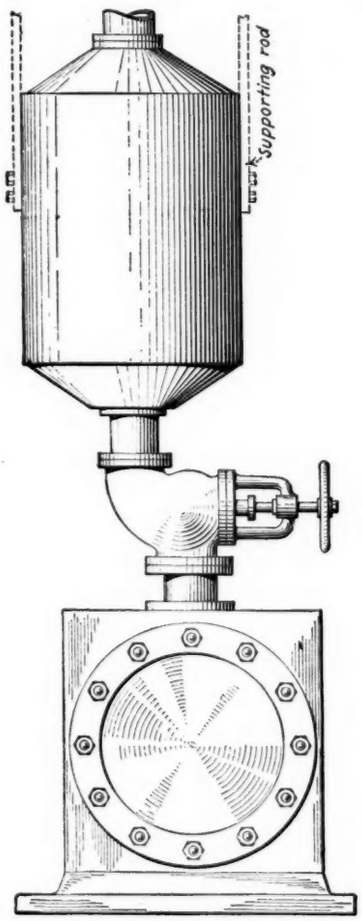
The bookshelf should be regarded as an indispensable part of a power-house equipment, and by careful additions and judicious scrappings should be kept up to date and efficient, just in the same way as the whole power plant is treated. In a general way all an engineer requires can be contained on two shelves three feet long. One shelf might be kept for books of reference, scientific treatises and the engineer's own notebook, and the other reserved for trade catalogs and the engineering journals. With regard to the latter it is suggested that the three most recent issues be kept, and that an hour each week be set apart for cutting extracts, pasting them in the notebook and card-indexing any articles that are interesting but not of sufficient importance to warrant inclusion in the notebook.

It is remarkable how the practice of keeping a good bookshelf increases the interest in engineering generally, and an engineer who has neglected the theoretical and literary side of his job will find that the best way to recover enthusiasm is to begin to build up a shelf of good engineering literature.

Dallas, Tex. CHARLES HURST.

## A Leaky Throttle Valve

In a plant under my charge the throttle valve on a Corliss engine leaked from the first week after the engine was started. This valve, which was of the usual type shown in the illustration, could not be made tight. New seats and new rings were repeatedly installed, but the leak continued. Since the plant only ran in the




SUPPORTS FOR SEPARATOR

daytime, there was always a large quantity of water in the cylinder each morning, and at least once the engine started up due to the steam leakage.

After trying a lot of different tricks, I decided that the weight of the large receiver separator was distorting the valve body, causing the leaking. So I placed two suspension rods on the receiver and fastened the top ends to the roof truss. By tightening up on the

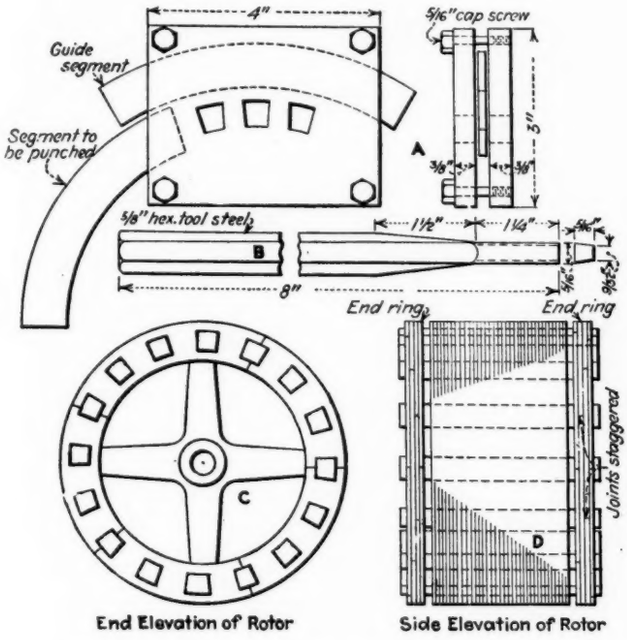
rods almost the entire separator weight was taken off the valve. We inserted a new seat and a new valve disc. From that time on the throttle valve remained steam-tight, and it has required no attention for more than a year.

JOHN SPUGG.

St. Louis, Mo.

## Rebuilding the End Rings on a Squirrel-Cage Rotor

I recently had to inspect a 3-hp. motor that would not carry its load without overheating, and found that each rotor end ring was made up of four $\frac{1}{16}$-in. by $\frac{3}{8}$-in.




SHOWS HOW NEW END RINGS WERE MADE

copper rings. These had broken in so many places that they made poor contact with the rotor bars and offered a high resistance to the current. As the motor was back-geared and was in a place where it was impossible to belt another one to the load, it was necessary to repair the machine as soon as possible. To obtain new end rings from the manufacturer would require about a month, therefore it was decided to make these rings. This would have been easy if the rotor bars had been round, but instead they were $\frac{1}{16}$ in. on one side and $\frac{3}{32}$ in. on the other, which meant punching the holes.

A die and punch were made out of tool steel, as shown at *A* and *B* in the figure. To make the holes in the die, they were laid out by a piece of the old end ring and a hole drilled just a little smaller than the punch, which was made the same size as the rotor bar. The die was heated and the punch driven through the drilled holes, and the surface cleaned up with a file to make a neat job. The top and the bottom piece of the die were held together by $\frac{1}{16}$-in. capscrews. Each section of the rings was cut so that five segments made up one section, as shown in the end view *C*. All joints were staggered and the ends of the segments joined on the center of the rotor bars as indicated in the side view *D*.

While punching the segments, one was clamped between the top and bottom sides of the die, to act as a guide to bring the holes in line. When the first hole was punched, a rotor bar was inserted so as to insure the holes being punched with the required radius. The segments were cut $\frac{1}{16}$ in. wider than the old segments, so they could be turned off to the right width in the lathe after they had been soldered to the rotor bars. The motor was completed and put back in service in two working days, which was a great saving in time compared with that required to obtain new rings from the factory.

MARIN PHILLIPS.

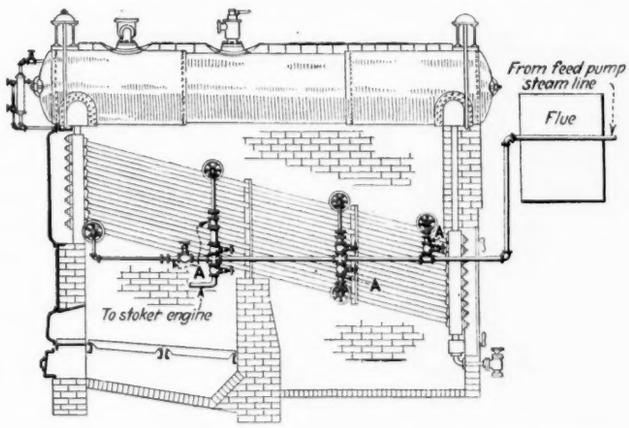
South Kaukauna, Wis.

## Commendable Arrangement of Soot-Blower Piping

In visiting a steam plant a short time ago, attention was drawn to an arrangement of soot-blower piping having some features which appear to be worth passing on. The idea is shown in the illustration.

Steam is taken from the feed-pump line, which is behind the boilers, passed through the smoke flue on each side of the setting and is carried straight forward. On the side adjacent to the stoker engine this main passes between the soot-blower heads, as shown, branches being made upward and downward to them and to the stoker engine. The engine keeps the line on this side of the setting free of condensation. On the other side of the setting, which was an extraordinarily wide one, requiring another set of soot blowers, the steam main passes below the heads and is drained in the usual way. Condensation is, however, reduced considerably, owing to a small amount of superheat received from the heat of the flue gases.

Each blower-head branch is provided with an expansion joint *A* (see sketch). This is an improvement over the usual method of connecting up with long pipes and




PIPING OF SOOT BLOWERS USING EXPANSION JOINTS

unions, as no matter how carefully the latter connections are made, the blower heads will work stiffly owing to expansion strains. The expansion joints cost very little more, and the heads will always work easily. The saving in the length of pipe is also considerable.

Montreal, Canada. A. L. MORGAN.

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Waterwheel-driven alternators are generally designed to stand an overspeed of 80 to 100 per cent, while engine-driven alternators, synchronous motors and motor-generator sets are designed to stand about 50 per cent overspeed.

# CORRESPONDENCE

## Taking Indicator Diagrams

In reference to Mr. Baumeister's reply to my statement that appeared in the Oct. 25 issue of *Power*, I am still of the opinion that he is radically wrong in his statement as to the cause of the errors in the two indicator diagrams, to which I took exception in my original letter. If there is any looseness of the indicator piston on the stem, and I cannot see how this is at all possible, it would not show any effect on the compression line. This slackness would be taken up as soon as the compression strokes began. When the play or slackness is taken up, the piston and pencil motion continues to travel upward without any such distortion as is shown on the indicator diagram under discussion. Since the pressure during the compression stroke increases gradually, there can be no great inerta to cause the pencil to jump.

I still cannot agree with Mr. Baumeister that the distortion in the re-expansion line is due to a stretched cord. In all the experience I have ever had with indicators, I never found a cord that stopped stretching suddenly. A cord is quite like a spring and will continue to stretch, the stretching process gradually diminishing until at a certain point the cord ceases to stretch and has a permanent length. Consequently, this cessation of stretch is not sudden, and the indicator drum is not given a sudden jerk. A stretching cord always gives a short diagram.

Jersey City, N. J. J. CASSIDAY.

## Residual Magnetism Causes Circuit Breaker To Open

The remarks by M. A. Walker, in the Oct. 18 issue, on peculiar fuse failures reminds me of another trouble that occurred when starting a large synchronous converter. It was not due to fuses blowing, because there were no fuses, but the circuit breaker opened instead. Had there been fuses instead of a circuit breaker, the probability is that no trouble would have been experienced, because the current rush would have been of such short duration that the heat-storage and conducting capacity of the fuse would not have permitted the temperature to reach a high enough value to melt the fuse.

The synchronous converter was supplied from three high-voltage transformers of 600 kw. each. The machine was always started from the alternating-current side, using one-third full voltage, then two-thirds voltage and finally full voltage. Ordinarily, the main-line circuit breaker would be closed after the starting switches were closed to the one-third starting taps on the transformers. On the occasion referred to, on closing the main circuit breaker on the high-voltage side of the transformers, the circuit breaker immediately opened, as if on short circuit.

Three times the circuit breaker was closed, and on each occasion it opened. Finally, the circuit breaker remained closed and the converter came up to speed, locked into step and ran normally. During the interim tests and inspections showed that there was nothing wrong with the transformers, the circuit or the machine. The explanation was found, as is so often the case, by adopting a hypothesis and then applying a theory to fit it. The decision reached was that residual magnetism in the transformer cores was the cause of the trouble. There is every reason to believe that this is the correct explanation.

The oil circuit breaker is effective in opening alternating-current circuits because it interrupts the current wave at zero value. But while the current value is zero, the value of the magnetism in the iron of the transformer is not zero because of the retentivity of the iron. Just how high the magnetism of the iron may be depends on conditions.

Now, when the potential is applied, as when starting the machine, the current may tend to magnetize the transformer iron in the same direction as that in which it is already magnetized, or it may tend to magnetize it in the opposite direction. Which occurs depends upon the point on the current wave at which the circuit breaker was closed. If the current happens to be in a direction to set up magnetism in the same direction as that which exists already, the change in the magnetic field may not be sufficient to prevent the current inrush from being excessive, and this explains why the circuit breakers repeatedly opened.

To prevent this condition, it is necessary, when shutting down the synchronous converter, to open the direct-current circuit breaker so as to drop the load. Then pull the equalizer switch (presuming that the machine is operating in parallel with other converters), after which open the high-voltage circuit breakers, but leave the alternating-current running switches closed until the armature has slowly come to rest. The field break-up switch should also be left closed until the machine is stopped; then these switches are opened.

The object back of this procedure is to permit a gradual decrease of the residual magnetism in the transformers as the voltage generated in the revolving armature dies out. If this procedure is always followed, there will never be any trouble from residual magnetism with synchronous converters. B. JONES.

Chicago, Ill.

## Why Do the Lights Flicker?

I read with considerable interest Mr. Groom's query in *Power* of Oct. 18 as to why the lights flicker. As this same sort of a flicker is connected with a painful incident in my career—the loss of my first job and that, too, just the day after I had found and removed the cause—and although this happened many years ago, the sore spot still remains; therefore when I learn of some one else in similar trouble, I am naturally sympathetic. The job referred to was a commercial lighting plant in my small home town, where I had learned all that I knew regarding engines and dynamos by acting as helper at "nothing per day" for its first two or three engineers. Finally came the great day when I landed the job myself, the engineer quitting unexpectedly.

The flicker put in its appearance a short time after I had fallen heir to the job, faint at first, but plainly apparent to my watchful eye. As time went on, it became more and more pronounced and finally complaints began to come in from the consumers. In the meantime I had considerably strained my small stock of knowledge in endeavors to find what was wrong.

Like Mr. Groom my suspicion first rested upon the governor. The engine, a high-speed automatic operating at 310 r.p.m., was equipped with a governor of truly fearful and complex design as compared with those of today, but all my tinkering with it produced no other effect than to cause the engine to race, and I hastily restored it to it's original condition. I was forced to admit that I did not know what was wrong.

This all happened before slate and marble had come into such general use for switchboard construction, and in this plant the switches, meters and rheostats were mounted directly on the building wall, which was a frame affair. On looking things over one evening, I chanced to peer into the rheostats, and in one I thought I saw a flash. I looked intently. Sure enough, there it was—right there was my long-sought flicker, flashing with the regularity of clockwork. The resistance elements in these rheostats were composed of german-silver coils attached to rectangular frames front and back and lay in a horizontal position. Heat and the strain of several year's use had caused some of the coils to sag, and the vibration of the wall did the rest. I easily remedied the trouble next day by placing strips of asbestos paper between the coils, but not in time to save my precious job.

I relate this incident mainly because it was of an unusual nature, but a much more prolific source of trouble, such as Mr. Groom describes, is to be found in the field connections both on the dynamo and on the switchboard. Examine carefully all connections in the field circuit, giving special attention to places where terminals are soldered to wires.

Special care is needed to do a good job of soldering at these points. Both the wire end and the hole into which it is to be inserted should be carefully tinned before any attempt is made to solder them; failure to take this precaution has produced many a bad joint. It often happens that a poorly made joint after a time in service will loosen up, vibration will vary the resistance of such a joint and cause a flicker in apparent synchronism with the engine. Sometimes only careful search will reveal such faults. In conclusion I would point out that faulty regulation of the governor will produce a wave in the voltage, but cannot produce a clear-cut flash.

Bellingham, Wash. O. B. CRITCHLOW.

## Remedy for Static Electricity in Belts

Replying to Mr. Peterson, page 651 of the Oct. 25 issue, take a piece of tin or sheet brass about 1½ in. wide and 12 in. long for a 24-in. belt, and notch one edge in saw-tooth style. Attach this to some rigid support of wood and place it about 1½ in. from the outside surface of the belt at a point where the sway of the belt is the least. Then attach a length of insulated wire to the piece of metal and connect the other end to a water or soil pipe for a ground to conduct the static away. R. A. CULTRA

Cambridge, Mass.

## Using a File on Bearings

Mr. Long's letter, on page 693 of the Nov. 1 issue, interests me. Some of the advice offered is undoubtedly good, but I cannot quite agree with him in some of the things he says. For example, he speaks of oil grooves in the lower shell of a bearing, as though he regarded an oil groove a necessity. If there is anything that would "break" an oil film quickly and permanently, it is an oil groove. The bottom part of a bearing or for that matter, any part of a bearing where pressure between the revolving member and the supporting bearing exists, should have no oil groove.

The chamfered edges referred to in Mr. Long's letter serve the purpose of starting a wedge-shaped film of oil, which is drawn into the bearing and will continue unbroken as long as oil is fed continuously and as long as oil of the correct body is used to suit the prevailing conditions.

Oil grooves in bearings should be considered only when conditions are abnormal, but for ordinary every-day practice there is no need of any grooves. The factors that influence the lubrication of bearings are as follows:

Size (diameter); speed (r.p.m. or surface speed); temperature at which bearing runs and whether the temperature is due to friction, induced heat or radiated heat; method of application of the lubricant; pressure (light, moderate or heavy); mechanical conditions, as to design, proportions, fit, etc.

When all these factors are taken into account, the correct lubricant can be provided, and there will seldom be any need of oil grooves to assist the lubrication, especially so as related to the bottom or pressure part of the bearing as a whole.

Mr. Long also speaks of introducing the oil to the point of greatest pressure. Of course he modifies this advice by stating that the force-feed system be applied, but even so, why should not the oil be introduced to the point of the least pressure, where the formation of a film is most likely? Possibly Mr. Long has in mind the footstep bearing of vertical turbines, where pressure lubrication was applied at the place of greatest pressure, but in that case the bearing was especially constructed to be run that way, while ordinary shaft bearings are not so made.

Heavy bearings, slow speeds, high pressures, high temperatures, must be lubricated with heavy-body oils, for light-body oils will not serve that type. The body of an oil has much to do with the formation and maintenance of the film referred to, and as I stated before, all the factors must be considered before an oil can be selected for the job. CHARLES J. MASON.

Brooklyn, N. Y.

# QUESTIONS AND ANSWERS

### Testing for Air Leaks in Condenser Connections

How can air leaks be located in the exhaust or water suction pipe connections when using a jet condenser? R. W. L.

If air is being drawn through the joints, the presence of a leak can be detected by slowly passing the flame of a lighted candle near the joint. The existence of a leak will be shown by the flame being drawn to its location. Or the places of leaks may be determined by subjecting the joints to hydraulic or steam pressure of about 20 pounds.

### Trouble with Corliss-Engine Dashpots

When the dashpot rods on our Corliss engine are adjusted to the proper length for operating the valves, the plungers strike hard on the bottoms of the dashpots, and when enough air is admitted for cushioning they will not close the valves quickly. How can the trouble be remedied? J. M.

It is possible that action of the dashpots will be improved by thorough cleaning and good lubrication. The trouble probably comes from leakage of air past the dashpot packing. If leather packing is used, it should be kept pliable and in good order; or if proper operation cannot be obtained with good packing, it may be that the dashpots are badly worn and need refitting.

### Pitch Line of Rivets

What is the pitch line of rivets of a riveted boiler joint, and where is it taken? W. H.

Pitch is the distance from center to center of rivets taken along a line passing through the centers of the rivets, called the pitch line. Strictly speaking, the pitch is to be taken through the centers of rivets at the section where the rivet is subjected to shearing stress. Thus for the lap joint of the girth seam of a cylindrical shell, unless otherwise stipulated, the pitch would be measured circumferentially along the inside of the outer plate; but in side seams the longitudinal pitch of each row of rivets would be measured parallel to the axis of the boiler and would be the same whether taken at a shearing plane of the rivet or measured center to center of rivets along the inside or outside of the boiler.

### Assistance of Staybolts to Strength of Shell Joint

Do the staybolts, in the firebox of an internally fired vertical cylindrical boiler reduce the stress on the longitudinal seam of the outer shell, and if so, how is the reduction of stress allowed for? F. N. G.

The longitudinal seam of the shell can be relieved of only as much girthwise stress as would be due to the safe working pressure for the material considered as a stayed surface and as limited by the support received from a staybolt when the boiler is under pressure. But the hold exerted by a stay is limited to its resistance when the ends are at bearings after elongation from the stress, and the elongation must be compatible with the relative positions simultaneously assumed by the bearing on the furnace sheet and the shell. Usually, when the conditions are taken into account, the assistance which the staybolt renders is equal to only a small part of the tangential stress in the shell, aside from the fact that the staybolt hold may be completely nullified by shortening of the distance between bearings as a result of distortion of the form of the furnace sheet from the collapsing pressure. Hence, in designing the side seams in the shells of vertical boilers, the uncertain assistance rendered by the firebox staybolts usually is neglected.

### Power Required to Drive a Single-Phase Generator

We have a load of 25 amperes on a single-phase 60-cycle 1,100-volt alternating-current generator, and I would like to know what the horsepower is required to drive the generator. All lighting circuits are at 110 volts stepped down from 1,100 volts through potential transformers. I have only a voltmeter and ammeter on the switchboard. A. J. C.

The power required to drive the generator at a given load will depend on the efficiency of the generator at this load and the power factor of the load, therefore the following can be only approximations. If the machine in question is operating at above 75 per cent of its rated capacity, it will be about 80 per cent efficient. If the load is incandescent lamps supplied from small step-down transformers, the power factor will be about 0.90, and if arc lamps are used, the power factor will be about 0.70. The horsepower required to drive the generator and its exciter equals *volts times amperes times power factor divided by* 746 *times efficiency*. Assuming that the load is incandescent lamps and the ammeter reads 25 and the voltmeter 1,100, then *horsepower* = $(1{,}100 \times 25 \times 0.90) \div (746 \times 0.80) = 41$ approximately. The value 746 is the watts per electrical horsepower.

### Greater Economy Operating Single Boiler

Where there is sufficient capacity for carrying the load with a single boiler, is it considered good practice and favorable to the economy of fuel to operate two boilers with the automatic dampers closed most of the time? J. L. F.

If the load can be carried by a single boiler at all times when steam is required, without forcing it beyond

50 per cent of its rated capacity, there will be better economy than to operate two boilers with either operated at less than three-fourths capacity. However, it must be borne in mind that hand-fired boilers, even when supplied with good coal, rarely can be operated at more than rating over greater periods than four or five hours on account of the drop of output during the time necessary for cleaning the fires and for re-establishing the required rate of combustion.

### Formula for Flow of Steam in Pipes

What is the formula for determining the quantity or weight of steam discharged or flowing, when the pipe size and pressure of steam are known? J. C. K.

Flow of steam, like the flow of a liquid, only takes place as a result of difference or drop of the pressure; that is, steam of higher pressure flows into a space where the pressure is lower. When the flow takes place in a pipe of uniform size, there is a gradual lowering of pressure all along the pipe, due to friction, quality of the steam and condensation. These influences are variable, and it is impossible to construct a simple algebraical formula that would be true for all conditions.

The formula commonly used and approximately true for conditions usually met in practice is

$$W = 87\sqrt{\frac{w(p_1 - p_2)d^5}{L\left(1 + \frac{3.6}{d}\right)}}$$

where

$W$ = Weight of steam flowing pounds per minute;
$w$ = Density in pounds per cubic foot of the steam at the entrance to the pipe;
$p_1$ = Pressure in pounds per square inch at the entrance;
$p_2$ = Pressure in pounds per square inch at the exit;
$d$ = Diameter of pipe in inches;
$L$ = Length of pipe in feet.

Putting the formula in the form

$$W = c\sqrt{w(p_1 - d_2)d^5 \div L},$$

in which $c$ will vary with the size of the pipe, gives for 1-in. pipe, $c = 40.7$; for 2-in., $c = 52.1$; for 3-in., $c = 58.8$; for 4-in., $c = 63$; for 6-in., $c = 68.8$; for 9-in., $c = 73.7$; and for 12-in. pipe, $c = 79.3$.

### Liquid for Use with Hydraulic Jacks

What is the best liquid that is non-freezing and non-explosive in ordinary outdoor temperatures to use in hydraulic jacks? A. C. M.

A liquid recommended by manufacturers of hydraulic jacks of long experience is a solution of pure grain alcohol one part and pure water two parts, and for a non-freezing mixture for use in cold weather equal parts of pure grain alcohol and pure water. The requisites of a liquid used for the purpose are that it must not freeze in cold weather; must not rust or corrode the polished surfaces of the cylinder and pump, in which case the packing would be cut; must not harden or destroy the leather packings; must not crystallize or encrust the valves and valve seats; and must not gum or clog the valves, valve seats or passages.

Wood alcohol, denatured alcohol, kerosene, oils, glycerin and water should not be used. Water is likely to freeze and to rust the jack when not in use. Kerosene destroys the packings, and wood alcohol both destroys the packings and corrodes the metal surfaces. Commercial denatured alcohol commonly contains wood alcohol and corrodes the metal surfaces, but not so seriously as wood alcohol alone. Heavy oils and glycerin soften the packings and gum and clog the valve parts. The liquid used should be free from grit and dirt so that it will not injure the polished surfaces of the cylinder and pump and will not cut the valves or packings.

### Unbalanced Voltage on a Three-Wire Circuit

If the load on a 120-240-volt system is unbalanced as in the figure, and the neutral happens to open, the voltage will increase across the two lamps from $D$ to $E$ and decrease across the five lamps from $C$ to $D$. What takes place in the circuit to cause this unbalance of the voltage? R. M. A.

Assume that each lamp has 120 ohms resistance, then on 120 volts each will take one ampere, or volts $\div$ ohms $= 120 \div 120 = 1$. Therefore in the figure with the neutral closed five amperes will flow through the five lamps connected between $C$ and $D$, three amperes of which will flow back on the neutral to machine $A$ and

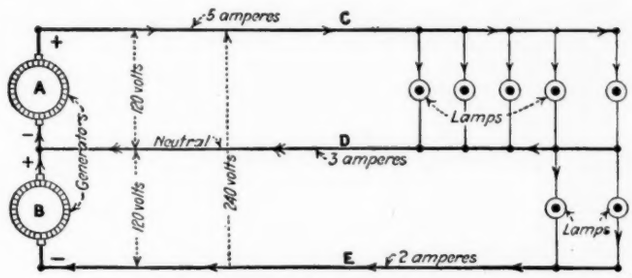


DIAGRAM OF THREE-WIRE CIRCUIT

the other two amperes will flow through the two lamps from $D$ to $E$ and back to the negative of machine $B$, as indicated by the arrowheads. Under these conditions each lamp gets its normal current and the voltage remains practically balanced.

Now assume that the neutral is open, then the current that flows through the five lamps from $C$ to $D$ must also flow through the two lamps from $D$ to $E$. Each lamp has 120 ohms resistance; then the joint resistance of the five in parallel, will be $\frac{1}{5}$ of 120, or 24 ohms, and of the two in parallel, $\frac{1}{2}$ of 120, or 60 ohms, This gives a total resistance of $24 + 60 = 84$ ohms between lines $C$ and $E$. With 240 volts applied across this resistance, the current will equal volts divided by ohms, or $240 \div 84 = 2.86$ amperes. That is, there will be 2.86 amperes flowing from $C$ to $E$. The volts drop across any section of a circuit is equal to the current times the resistance, therefore, the volts drop across the five lamps from $C$ to $D$ equals $2.86 \times 24 = 68.64$ volts, and across the two lamps from $D$ to $E$ is equal to $2.86 \times 60 = 171.60$ volts, instead of 120 volts when the neutral is closed. It will be noted that not only is the voltage unbalanced but the current (2.86 amperes instead of 2) is excessive through the two lamps from $D$ to $E$, and through the five lamps from $C$ to $D$ the current is low, being 2.86 instead of 5 amperes.

[Correspondents sending us inquiries should sign their communications with full name and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

## Annual Convention of the Practical Refrigerating Engineers

The annual convention of the National Association of Practical Refrigerating Engineers was held at the Hotel Lorraine, Philadelphia, Pa., Nov. 30 to Dec. 3. A number of very interesting papers were read. The comparative merits of the wet and dry compression system were discussed by Van R. H. Green. The subject of absorbers in absorption plant covering the several types and methods of operation was covered in a paper by James Anderson. Charles R. Neeson, in a paper on "Working Temperatures and Pressures," covered the proper method of operating the refrigeration plant by the assistance of temperature readings. As he pointed out, the suction and discharge pressures considered alone do not reveal to the engineer the results being obtained. He suggested that a few degrees of superheat in the suction was desirable in order to insure dry gas at the suction valve.

The proper locations for thermometers was raised. Mr. Neeson stated that thermometers should be placed at the compressor, on both the suction and discharge sides, and in addition thermometers should be placed at the receiver and at the coil outlet. Attention was called to the danger of thermometer errors if the thermometer was not insulated against the outside air. If the end is exposed, the reading may have an error of as much as 10 deg. Permanent recording thermometers were recommended and arranged to be thoroughly insulated against the influence of the pipe, which is often several degrees above the gas temperature.

After cooling of liquid ammonia by means of a double-pipe arrangement was favored in a paper by H. T. Whyte. The author outlined the method of using a type of cooler where ammonia at a fairly high suction pressure was evaporated in a double-pipe cooler, in order to cool the liquid going to the working coils. It was claimed that a substantial saving was effected by this system. Several questioned this statement, it being claimed that since the heat taken up by the cooling ammonia just equaled that lost by the liquid line, no increase in economy could be obtained.

The question of safety devices was discussed by F. W. Niebling in a paper entitled "Safe and Sane Ice-Machinery Construction." The author questioned the advisability of using inclosed crankcase compressor of above 20 tons capacity on the grounds that the danger of the discharge pressure entering the frame and wrecking it was by no means negligible. He also expressed the opinion that safety valves as now constituted were not leakproof, were dangerous and wasted much ammonia. The pressure of light cast-iron fittings in the plant was also found objectionable.

An outline of the development of the ammonia compressor-rod packing, by A. C. Judd, was read by another member. The author expressed the belief that fibrous packing was of little if any benefit in the compressor and strongly recommended the use of some one of the several metallic packings on the basis of less total cost, lowered frictional resistance and less operating trouble.

The "Selection of Prime Movers" was the subject of an interesting paper by Peter Neff, consulting engineer, Canton, Ohio. Mr. Neff took the stand that only in exceptional cases was the electric motor more economical than a modern steam-engine plant. Since the tendency of electric rates is upward, he voiced the belief that owners should give careful consideration to the poppet or Corliss-valve engines before installing electric power.

Fred E. Rogers discussed oxyacetylene welding in the refrigerating plant. He claimed that the majority of pipe-fitting jobs could be handled by welding to better advantage than by threaded fittings. Various welding operations were illustrated by lantern slides, and the author stated that any engineer could quickly learn the proper manipulation of the welding apparatus. On the other hand, several members felt that welding required long training.

"The Future of the Refrigeration Engineer" was the subject of a paper by Dr. John E. Starr, of New York City. Victor J. Azbe, St. Louis, read a paper on "Refrigerating Plant Economy Standards and Records." In this were presented a number of standard forms for refrigerating-plant records and the necessity of record keeping if efficiency was to be secured was pointed out.

## Handling Power Problems in a Large Manufacturing Organization

In a paper presented by P. L. Smith, plant engineer of the Winchester Repeating Arms Co., in a recent meeting of the American Institute of Electrical Engineers at New Haven, Conn., many points were brought out that should be of considerable interest to engineers who are up against the practical problems of isolated-plant operation. A short abstract of this paper is given here.

More than any other part of the plant the boiler room requires continual watching if efficiency and economy are to be obtained. In the Winchester plant a difference in evaporation of one-tenth of a pound of water per pound of coal amounts to thousands of dollars in the annual expense.

You often hear a man condemn a certain make of stoker and praise another of the same type, although of different make. The stoker is not built that will replace intelligence, nor will it ever be. Stokers are automatic only in that they push fuel into the furnace, but they will not automatically give high efficiency. Any expense you may incur for instruments to measure your coal, water, draft, etc., will pay for itself in a short time if the information is used intelligently. Pay for brains and not for brawn in your boiler room.

One of the most important points to consider with your prime movers is lubrication. At times companies submit specifications for lubricating oil, stating the specific gravity, flash points, fire points, viscosity, etc., and expect to get the proper lubricants for their various requirements. While such specifications are doubtless of some value, experience has shown the frequent occurence of a condition where several grades of oil will meet the same specifications, while differing greatly in their lubricating qualities. Between oils that meet the same specifications the one with the lowest first cost usually wins out under this system of purchasing. The result is that you may obtain an oil that will meet the specifications, but will not meet your particular requirements.

In the opinion of the writer specifications do not serve the purpose intended, and the best method of selecting oil is to take your actual working conditions to a reliable oil company, let them investigate your conditions and test your equipment if necessary, and then let them prescribe accordingly. You can get this service without cost, and unless you have laboratories where the oil can be tested over an extended period under actual working conditions, it is far better than relying on mere specifications.

One essential difference between the central station and the isolated plant is that the latter has a more direct interest in seeing that its product is economically used by its consumers. If the coal bills run high, the power plant is usually blamed whether the fault lies in uneconomical production or in wasteful use. To insure the careful use of power, steam, compressed air, etc., the power department of the Winchester Repeating Arms Co. has a division called the substation shop. This shop is responsible for the care and maintenance of electric substations, isolated engines, blowers, central heating plants, pumps, etc. It is the duty of this shop to see that all steam and water leaks are stopped, that buildings are not overheated, that all unnecessary lights and motors are cut out of service, and in fact, to see that all products from the power department are conserved. The starting and stopping time of work in the various buildings is recorded on the station wattmeters, and shops are reported that do not take full advantage of the power during their scheduled time.

While troubles in a power department are many and varied, they can be reduced to a minimum, and maximum efficiency can be obtained by having harmony in the organization. This is the first requisite and must be established. Maintenance must be carefully followed, and nothing must be left undone to keep the entire equipment in the best possible condition at all times.

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The effort of the J. M. MacDonald Coal Mining Co. to recover $58,036 from the Government for losses due to the war-time restriction of prices has been denied by the Court of Claims. The case is similar to that of the Morrisdale Coal Co., mentioned on page 782 of *Power* for Nov. 15.

# News in the Field of Power

### Railroad Wages

According to figures recently given out by the Interstate Commerce Commission, the total earnings per employee in July, in certain lines of railroad work, were as follows: General foremen, electrical transmission, $238; assistant general foremen, electrical transmission, $215; electrical workers, Class A, $170; Class B, $167; Class C, $130; stationary steam engineers, $157; stationary firemen and oilers in steam and electrical plants, $130.

### Edison and Ford at Muscle Shoals

Thomas A. Edison has been co-operating actively with Henry Ford in the latter's effort to have his Muscle Shoals offer accepted by the Government. The two famous men made quite a thorough examination of the project, after which they set to work to prepare a written report on the matter for Secretary Weeks.

Mr. Edison emphasized the good results that would follow from the production of large quantities of nitrate, saying that this would really be "peace insurance," nitrates being indispensable in modern warfare. He said also that cheaper fertilizer, resulting from the plant's output of nitrate, would double the production of cotton and wheat in the South.

### Westinghouse Co. to Electrify Chilean Railroads

What is said to be the largest and most comprehensive single order for electrification equipment ever received in this country has been obtained by the Westinghouse Co. Present plans cover electrification of 144 miles of railroad, supplying 39 electric locomotives, and construction of a 30,000-kw. hydro-electric power plant in Chile.

The decision to put into effect a comprehensive policy of electrification was the result of the report of a Chilean commission that was appointed in 1918 to study the subject. It was decided to begin at once in electrifying the broad-gage lines, beginning with the so-called first zone, which includes the Valparaiso-San Diego and Los Angeles branches. For this purpose a loan of 10½ million dollars was authorized and heavily oversubscribed.

The new hydro-electric plant, which is already under construction, will develop 30,000 kw. at 50 cycles, three phase, which will be transmitted at 110,000 volts. The plant will be tied in with a hydro-electric and a steam station, both of which were built some years ago by the Germans and also operate at 50 cycles three phase. The total capacity of the three stations will be about 120,000 kw.

The power supply will be distributed through five sub-stations, which have capacity enough for a 50 per cent increase of train movement over that of 1917, with provision for handling three times the 1917 demand, if necessary. The power will be used as 3,000-volt direct current. The express passenger and road freight locomotive will use the Westinghouse system of regenerative braking.

### Prize Offered for Renaming "The Engineer"

Mrs. Harry Payne Whitney's statue of "The Engineer," which was commented on in *Power* for Nov. 1, has come in for some further criticism at the hands of *Engineering and Mining Journal*, another McGraw-Hill paper. In the Nov. 12 issue of the *Journal* a photograph of this remarkable work of art is published under the significant title "What Is It?" Furthermore, suggestions for a more suitable name are invited, and a prize of a box of Chiclets is offered for the best answer. The *Journal* itself offers a guess that it "represents a mucker before he acquired common sense enough to use a long-handled shovel," but asks, on the other hand, "Do not muckers wear overalls over their union suits?"

Some of the answers are interesting. One reader thought the figure looked like a miner suffering from home brew, his strained posture and lack of proper clothing showing his befuddled condition. Another gave Mrs. Whitney credit for being partly right, saying: "She doubtless had in mind the engineer before he woke up and undertook to play his part in public life. Some technical men are still asleep, and these she is not far wrong in representing as she has."

Two of *Power's* readers have gallantly suggested that the sculptress had in mind an army engineer, and so should not be criticized. It is the result rather than the object that counts, however; one guess is as good as another, and all kinds are being made. H. W. Rose, in *Power* for Nov. 29, suggests as a title "Frontier Farmer Clearing His Land of Boulders and Rocks," but that seems a trifle long. Charles J. Miller, a combustion engineer of North Tonawanda, N. Y., writes: "Engineers should put themselves before the public in every way possible," an excellent thought that Mrs. Whitney seems entirely in sympathy with, although her helpfulness in carrying it out is questionable.

### Extra! Convention Issue!

***THE BIG Sunday newspapers with their beautiful brown "Rotogravure" sections will have nothing on next week's "Power," which will tell the story of the A. S. M. E. annual meeting from A to Z. The report will cover about 16 pages, which will be of brown paper, with "sepia" ink.***

***The big convention took place last week, but did not close until this issue of "Power" went to press. Therefore the story has been saved for the Dec. 20 issue, and there will be time to make it full and thorough, yet brief and readable.***

***Every paper that will interest power-plant men will be given in condensed form, non-essential matter being cut out; the gist of the discussion on each paper will be given; important decisions made at the business meeting will be presented briefly; the presidential address and other big features will be summarized concisely. In other words, the report will be "boiled down," and the essential facts that a man would gather by attending the convention throughout the week will be concentrated in convenient form.***

### Shoshone Dam Plant To Be in Operation Jan. 1

It is expected that the power plant being built by the United States Reclamation Service just below the Shoshone Dam near Powell, Wyoming, will begin operation shortly after Jan. 1, 1922. Power will be supplied to the towns of Powell, Cody, Garland and Denver, and will also be used in construction of the Willwood Dam and additional canals.

The plant is being equipped with two 1,100-hp. Wellman-Seaver-Morgan turbines direct-connected with G. E. generators. A third unit of 3,200-hp. capacity will probably be installed later.

### Central Stations Have 54 Days' Coal Supply

The Government's questionnaire on bituminous coal stocks, which was sent out recently in an effort to find out how much coal is in the hands of consumers, has brought out information indicating a total of 47,400,000 tons on hand Nov. 1, as compared with 63,000,000 tons at the same time last year. This represents a supply that would last 43 days.

Although the total stock is lower this year than last, the public utilities have increased their supply, and are better off in that respect than at any time since Jan. 1, 1919, according to the Government's figures.

The estimated average supply in the hands of various classes of consumers is given as follows: Railroads, 29 days; steel and coke plants, 42 days; other industries, 67 days; gas works, 87 days; electric public utilities, 54 days; coal dealers, 47 days.

It is announced that the next inventory of this nature will be made as of Jan. 1.

### Secretary Fall Pushing Colorado River Project

Whether the Colorado River development is to be carried on by private capital under Government control or regulation, or through direct Governmental appropriation, it is being urged by Secretary Fall that a decision be reached promptly and the development carried forward speedily, on account of the constant danger from the flood waters of the Colorado River. At one point in a report that he recently made to Congress he said:

The development of hydro-electric power through private initiative is going on in the West. It may be perfectly feasible to develop such power by private initiative on the Colorado; if so, then such initiative should be encouraged by the Government and the power developed should be under the final control of the Government to the extent that those states to which it can be conducted may receive their proportionate benefit as the demand in such state increases, irrespective of the present immediate demand in those states, which at this day can take a greater amount of such power. Whether this result can be attained by any other than Government construction is a serious question in my mind. That it must be attained by such governmental construction, or in any event by the United States Government control, to me appears to be self-evident.

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Appropriations totaling $1,632,560 have been submitted to Congress to cover the expense of work planned for the next fiscal year at the Bureau of Standards. Some of the items are: Investigation of internal-combustion engines, $45,000; standardization of instruments and machinery, $100,000; elimination of waste, $150,000; investigation of mechanical appliances, $15,000; testing materials $30,000; investigation of public-utility standards, $85,000.

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A. E. Killebreu, of Newton, Ala., has applied to the Federal Power Commission for a preliminary permit to cover a power project estimated at 1,200 hp. of primary power. He plans to install equipment with a capacity of 5,000 hp. and to build a dam 80 ft. high in the Choctawhatchee River just above the town of Newton. The power is to be used for public utility purposes.

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The G. E. Company is making extensive plans for the manufacturing of large apparatus for stock and the accomplishment of considerable repair and maintenance work through the coming Winter, as a means of keeping its employees busy as soon as the limitation of armanent plan begins to tie up work at its Schenectady plant.

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Objections to burning corn for fuel have reached Washington, following recent discussions of the subject. Western economists object to burning a food product for fuel, saying the resulting economic loss offsets whatever immediate saving seems apparent.

## New Publications

**Elevator Accidents.** Technologic paper No. 202 of the Bureau of Standards, sold by the Superintendent of Documents, Government Printing Office, Washington, D. C. Thirty pages. Price 5 cents.

Results are given of a survey of elevator interlocks, with a summary of the advantages and disadvantages of the various types of such devices, and an analysis is given of elevator accident statistics, which show that 73.8 per cent of all fatal accidents might be prevented by well-designed interlocks.

**Powdered Coal.** The Preparation, Transportation and Combustion of Powdered Coal," by John Blizard. Published by the Director, Mines Branch, Department of Mines, Ottawa, Canada. Size 6½ x 10 in.; 130 pages.

This report is based on field studies made during August and September, 1919; in March, 1920, Mr. Blizard resigned from the Mines Branch and took a position as fuel engineer with the United States Bureau of Mines. The report was completed later and has since been brought up to date. The scope of the booklet is not by any means confined to Canadian systems and installations, for the effort was to make a comprehensive review of everything that has been done in the development of pulverized-coal apparatus.

## Obituary

**Jarrot P. Dugger,** secretary of the Kewanee Boiler Co., of Kewanee, Ill., died recently, according to an announcement just received from the company.

**Timothy J. Lynch,** for some thirty years superintendent of the Danvers (Mass.) municipal electric lighting department, was killed recently in a street railway accident in Salem, Mass. He was 64 years old and his plant was among the earliest municipal stations in the country.

## Personals

**P. Alfred Croney** is now mechanical and electrical engineer in charge of design in the offices of Phillip H. Johnson, a Philadelphia architect.

**William A. Durgin** has been given leave of absence by the Commonwealth Edison Co., of Chicago, to take charge of the new elimination of waste division of the Department of Commerce.

**Edward R. McCuiston,** formerly mechanical engineer with the Bethlehem Steel Company, has taken the same position with the Phoenix-Portland Cement Company, of Nazareth, Pa.

**William C. Davis,** now of Pawtucket, R. I., and for the last fifteen years chief engineer of the United States Cotton Co.'s plant, can boast a membership of forty-one years in Providence Association No. 1 of the N. A. S. E. He is reported as still on the job every day and still studying.

**E. S. Volk,** formerly with P. Nacey & Co., and a member of the Western Society of Engineers, has opened offices at 708 North Carpenter St., Chicago, as engineer and contractor for the installation of automatic sprinklers and for heating, ventilating and power work.

**Dr. Ernest Fox Nichols** has resigned from the presidency of the Massachusetts Institute of Technology. He was inaugurated only last June, but severe illness came upon him shortly and has now forced him to give up the work entirely. Dr. Elihu Thompson, consulting engineer of the General Electric company, will resume the chair of acting president.

## Society Affairs

**Metropolitan Section, A. S. M. E.,** will hold a "Pulverized Fuel" meeting Dec. 16, with an afternoon trip through the Babcock & Wilcox plant, as noted in *Power* for Dec. 6.

**The Kansas Engineering Society** will hold its annual meeting Dec. 22-23 at Hutchinson. There will be business and professional sessions. Conservation and public service will be stressed.

**The Associated Technical Societies of Detroit** will hold their fourth meeting under the sponsorship of the American Society of Heating and Ventilating Engineers on Dec. 16 in the Board of Commerce auditorium. Prof. J. D. Hoffman, of Purdue, will speak on "Co-operation."

**Hartford Branch, A. S. M. E.,** will consider "Air Conditioning and Refrigeration" at its Dec. 19 meeting at the plant of the Hartford Electric Light Co., after a dinner at the Hotel Bond at 6:30 p.m. Illustrated talks will be given by J. E. Bolling, of the Carrier Engineering Corp., and by L. M. Church, of the Automatic Refrigerating Co.

**Philadelphia Sections of the A. S. M. E., the A. I. E. E. and the A. I. S. E. E.,** with the Engineers Club of Philadelphia and the Chamber of Commerce, will hold a material-handling symposium comprising an afternoon session, dinner and evening session at the Bellevue-Stratford Hotel, Dec. 20. The afternoon meeting will be in the Chamber of Commerce auditorium.

**The Engineering Society of Western Massachusetts,** at its Nov. 22 meeting in Greenfield, Mass., heard the story of the G. E. company's new million-volt transformer from C. C. Chesney, who was in charge of experiments made on the device. C. P. Perin, a New York consulting metallurgical engineer, who has traveled over the greater part of the Globe, told of the industrial develop-

ments of India and of his work there in the Tata Steel Works. Both talks were illustrated with motion pictures.

## Business Items

**The Andrews-Bradshaw Co.,** sales engineers, has moved from the third to the eighth floor of the B. F. Jones Building, Pittsburgh, Pa.

**The Uehling Instrument Co.,** of New York City, has elected Charles C. Phelps, treasurer.

**The Blaw-Knox Co.,** Pittsburgh, Penn., has announced the removal of its New York office from the City Investing Building to the Carbide and Carbon Building, 30 East Forty-second St.

**The Kargé-Baker Corp.,** manufacturer of the Kargé flexible couplings and systems of transmission, has moved its plant and head office from Phoenix, N. Y., to 658 Ellicott St., Buffalo, N. Y.

**The Howard Iron Works and the Alberger Heater Co.,** manufacturer of expansion joints and heaters, now have offices at 728 Monadnock Building, Chicago, Ill., in charge of G. W. Heald and A. J. Saxe.

**The R. H. Beaumont Co.,** Philadelphia, Pa., is increasing its sales force as follows: P. K. Reed, formerly chief engineer, will enter the sales department at Philadelphia; H. D. Williams, a former engineer, will enter sales work at the New York office. The Pittsburgh Office will move to the Oliver Building in charge of Charles W. Ross, formerly New York manager.

**The Power Plant Products Co.** has opened offices at 419 Erie Building, Cleveland, Ohio, as the representative for "John Crane" flexible metallic packing, Godfrey coal and ash conveyors, Milwaukee steel storage tanks, Protected Seat valves for high-pressure work, Sterling return vacuum and separating traps, Uehling instruments and United stokers.

## Trade Catalogs

**Refrigerating Machinery.** — F. W. Niebling & Co., Cincinnati, Ohio. Catalog 4, describing Niebling compressors and containing also some data on power costs.

**Pipe Coverings**—National Tube Company, Frick Bldg., Pittsburgh, Pa. Bulletin No. 8, 12 pages, dealing with protective coatings for pipes, particularly for underground service. A well-illustrated booklet discussing methods of coating and laying pipes so as to prevent corrosion.

**Turbo-Alternators** — Allis-Chalmers Manufacturing Co., Milwaukee, Wis. Bulletin No. 199, 58 pages, "Steam Turbine and Alternator Units." A valuable booklet covering clearly principles and details of construction of high-pressure, single-cylinder condensing units, ranging from 5,000 kw. to 15,000 kw., 1,500 or 1,800 r.p.m., and containing also instructions for operation and adjustment.

**Packing**—James Walker & Co., Ltd., 36 West St., New York City. An attractive 52-page catalog giving specifications and prices of "Lion" packings for steam, water, refrigeration and oil uses, jointings and similar materials.

**Chain-Grate Stokers**—Illinois Stoker Co., Alton, Ill. Catalog L, second edition, a 32-page booklet giving the arguments for the chain-grate stoker, with particular emphasis on air control, and describing the company's stokers of both the natural- and forced-draft type, with a number of installation layouts for different types of boilers.

## FUEL PRICES

### BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

| Coal | Market Quoting | Nov. 28, 1921 | Dec. 5, 1921 |
|---|---|---|---|
| Pool 1, | New York | $3.00 | $2.75@3.25 |
| Pocahontas | Columbus | 2.35 | 2.15@2.35 |
| Clearfield | Boston | 1.80 | 1.60@2.00 |
| Somerset | Boston | 1.85 | 1.65@2.00 |
| Pittsburgh | Pittsburgh | 2.15 | 2.10@2.20 |
| Kanawha | Columbus | 1.85 | 1.80@2.00 |
| Hocking | Columbus | 2.00 | 1.90@2.00 |
| Pittsburgh No. 8 | Cleveland | 2.05 | 2.00 |
| Franklin, Ill. | Chicago | 2.75 | 2.50@3.00 |
| Central, Ill. | Chicago | 2.35 | 2.00@2.50 |
| Ind. 4th Vein | Chicago | 2.75 | 2.60@2.90 |
| Standard | St. Louis | 1.95 | 1.85@2.00 |
| West Ky. | Louisville | 1.90 | 1.50@2.00 |
| Big Seam | Birmingham | 2.00 | 1.50@2.50 |
| S. E. Ky. | Louisville | 2.10 | 2.00@2.10 |

**New York**—On Dec. 7 Port Arthur light oil 22@25 deg Baumé, 5c. per gal.; 30@35 deg., 6c. per gal., f.o.b. Bayonne, N. J.

**Chicago—Nov. 26,** for 24@28 deg. Baumé, 95c.@$1 per bbl.; 32@36 deg., 3@3¼c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

**Pittsburgh**—On Dec. 6, f.o.b. refinery, Pennsylvania, 36@40 deg., 6@6¼c. Oklahoma, 24@30 deg., 80@90c. per bbl.; gas oil, 32@34 deg., 3@3¼c. per gal., 34@36 deg., 3¼c., 38@40 deg., 3½c. per gal.

**St. Louis**—Dec. 3, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 90c. per bbl.; 26@28 deg., $1; 28@30 deg., $1.10; 32@34 deg., 2¾c. per gal

**Philadelphia** — On Dec. 5, 26@28 deg. Baumé, Oklahoma, 95c.@$1.00 per bbl.; 30@34 deg., Oklahoma (group 3), 95c.@$1.00 per bbl.; 16@20 deg., Seaboard, $1.15 per bbl.

**Cincinnati** — Dec. 6, for 26@34 deg. Baumé, 4⅜c.; Diesel 34@36 deg., 5c. per gal.; distillate 38@40 deg., 5½@6c. per gal.

**Cleveland**—Dec. 6, for 26@34 deg. Baumé, 3⅞c. per gal.

## New Construction

### PROPOSED WORK

**N. Y., Marcy**—The State Hospital Comn., Capitol, Albany, will receive bids until Dec. 21 for a cold storage bldg. and kitchen at the Marcy State Hospital, here.

**N. Y., New York**—N. J. Hayes, Comr. Water Supply, Room 2351 Municipal Bldg., will receive bids until Dec. 16 for transferring one Worthington 3 M. G. pumping engine from West Brighton Pumping Station to Clove Pumping Station and for transferring one 3 M. G. Davidson pumping engine from New Lots pumping station to West Brighton pumping station.

**N. Y., New York**—The 242 and 252 West 36th St. Corp., c/o Schwartz & Gross, Archts., 347 5th Ave., will soon receive bids for a 13 story, 98 x 128 ft. light manufacturing bldg. at 215-52 West 36th St. About $950,000.

**Pa., Philadelphia**—Farmers Cold Storage Co., c/o G. T. Sales, Liberty Bldg., is having plans prepared for a 4 story, 90 x 100 ft. cold storage plant on Levick St. and Delaware Ave. About $200,000. Ophuls, Hill & McCreery, Inc., 112 West 42nd St., New York City, Engrs. Refrigeration machinery will be installed.

**Pa., Philadelphia**—Neubauer & Supourtz, Archts., 929 Chestnut St., are preparing plans for a 3 story, 72 x 100 ft. turkish bath bldg. including a steam heating plant at 16th and Locust Sts. About $200,000. Owner's name withheld.

**D. C., Washington**—F. H. Smith Co., 815 15th St., is having plans prepared for a hotel. About $3,000,000. J. H. DeSibour, Hibbs Bldg., Archt.

**Va., Fort Royal**—Gooney Manor Copper Co., Inc., H. E. Naylor, Vice Pres., is in the market for one Leyner water, air rock drill, steam driven air compressor of 150 cu.ft. per min. free air, 500 ft. ¾-in. or ⅞-in. wire cable for hoist, also one 5,000 gal. tank for water reservoir, wood or steel.

**N. C., Goldsboro**—The State Hospital, W. W. Faison, Supt., is receiving bids for furnishing boilers, engines and electric generating equipment. H. A. Underwood, 227 Forest St., Raleigh, Engr.

**N. C., Raleigh**—The city is having plans prepared for the construction of 250,000,000 gal. impounding reservoir, enlarging present reservoir, pumping plant and filter plant, also extensions to pipe lines and construction of 750,000 gal. steel tank and tower. About $500,000. J. B. Bray, 406 West Hargett St., Engr.

**Fla., Archer**—The Maddox Fdry. & Machine Co., Inc., H. Maddox, Pres. and Mgr., is in the market for a 5 to 6 ton compression ice machine, direct connected to a steam engine, with equipment for two cold storage rooms, 12 x 24 ft.

**Ala., Birmingham**—The Benoit Coal Mining Co., 1927 Jefferson County Bank Bldg., is in the market for one 5 hp. 1200 r.p.m., one 7½ hp. 900 r.p.m. and one 15 hp. 900 r.p.m. induction motors; all 60 cycle, 3 phase, 220 volt, with rail base, pulley, and starting compensator. One 10 hp. 900 r.p.m., one 10 hp. 720 r.p.m., one 15 hp. 720 r.p.m. and one 15 hp. 900 r.p.m. induction motors, all 60 cycle, 3 phase, 220 volt, with starter.

Three 25 kva., 60 cycle, single phase, pole type power transformers complete with fuses but no supension hooks, also 14,200 ft. transmission lines (used, if in good condition).

**Ky., Louisville**—The Kentucky Baptists, M. B. Hunt, Chn., 824 Cecil Ave., is having plans prepared for a 3 or 5 story, 100 x 150 ft. hospital on Barrett Ave. About $500,000. Joseph & Joseph, Francis Bldg., Archts.

**Ky., Louisville**—The United Casket Co., 3022 West Chestnut St., is having plans prepared for a 1 story, 100 x 450 ft. dry kiln factory and a 1 story, 40 x 40 ft. boiler plant at 12th and Magazine Sts. About $300,000. M. Sartoro, Cleveland, O., Archt. and Engr.

**O., Cleveland**—The city received bids for furnishing 8 steam turbine reduction gear driven centrifugal pumping units from Dravo-Doyle Co., Leader News Bldg., $410,-950; Allis Chalmers Mfg. Co., 122 South Michigan Ave., Chicago, Ill., $464,900; and the Worthington Pumps & Mchy Co., Rockfir. Bldg., $510,000. Noted Nov. 15.

**O., Dayton**—The Pythian Castle Co., 329 South Main St., plans to build an 8 story hotel and auditorium including a steam heating system on South Main St. About $300,000. Architect not selected.

**O., Marion**—The Hornell Ice & Cold Storage Co. received low bid for a 2 story, 60 x 90 ft. addition to ice plant from Blome-Sinek Co., 139 North Clark St., Chicago, Ill., $45,000. Ice making machinery will be installed to bring capacity to 120 tons per day.

**O., Martins Ferry**—The Bd. Educ. is having plans prepared for a 2 story high school. About $450,000. C. W. Bates, 77 12th St., Wheeling, W. Va., Archt.

**O., Middletown**—The Bd. Educ., M. E. Danford, Pres., will receive bids about Dec. 15 for a 2 story high school. About $500,000. T. D. McLaughlin, 610 Savings Bldg., Lima, Archt. Noted Jan. 18.

**Mich., Crystal Falls** — The Peninsular Power Co., Natl. Bank Bldg., Madison, Wis., is receiving bids for a 1 story electric sub-station here, and equipment. About $25,000. Mead & Seastone, State Journal Blk., Madison, Wis., Engrs.

**Mich., Detroit** — The Bd. Fire Comrs., Wayne and Larned Sts., received bids for furnishing and completing electrical equipment for high pressure pumping station including connections and control for 3 electrical driven centrifugal pumps from Turner Eng. Co., 452 West Larned St., $50,461; Miller & York, 451 Larned St., $53,845; and J. Livingstone & Co., 13 Campau Bldg., $54,790. Noted Nov. 1.

**Mich., Flint**—The Bd. Educ., c/o A. J. Wildanger, Secy., will receive bids until Dec. 28 for a 3 story, 160 x 440 ft. school bldg., including boilers, pumps, piping, etc. for separate power plant on Crapo St. Cost over $1,000,000. Malcolmson, Higginbotham & Palmer, 405 Moffat Bldg., Detroit, Archts.

**Ill., Chicago**—R. Edelson & H. Paullin, 11 South LaSalle St., plans to build a 4 story, 125 x 200 ft. apartment on B'way and Oakdale Ave. About $300,000. Architect not selected.

**Ill., Chicago**—C. F. Henry, c/o R. F. France, Archt., 155 North Clarke St., is having plans prepared for a 7 story, 100 x 175 ft. apartment including a steam heating system at 20-28 Cedar St. About $500,000.

**Ill., Chicago**—Michael Reese Hospital, 29th and Ellis Ave., M. E. Greenebaum, Dir., plans to build a 7 story, 100 x 150 ft. nurses home including a steam heating system. About $750,000. Architect not selected.

**Ill., Chicago**—B. J. Morris, 140 South Dearborn St., is receiving bids for a 3 story, 125 x 155 ft. store, office and apartment bldg. including a steam heating system on North Kedzie and Eastwood Aves. About $300,000. A. L. Himelblan, 179 West Washington St., Archt.

**Ill., Chicago**—The Nemo Dye Wks., c/o P. Gerhardt, Archt., 64 W. Randolph St., is receiving bids for a 1 story, 103 x 115 ft. factory at 4203-19 West Grand Ave. About $250,000.

**Ill., Elgin**—The Citizens Hotel Co., c/o C. Ackermann, 470 Douglas Ave., plans to build a 4 story hotel (Gifford) including a steam heating system. About $300,000. Architect not selected.

**Ill., Mt. Vernon** — The city plans intercepting sewer, settling tank, trickling filter, sludge bed and water supply including the installation of one 4 in. pump with 7.5 hp. motor. About $180,000. A. C. Stanfield, Mt. Vernon, Engr.

**Wis., Antigo**—The Howe Creamery Co. is in the market for 10 ice machines, 40 qt. continuous freezer machine, and other dairy machinery.

**Wis., Burlington**—The Kellogg Ice Cream Co. is in the market for ice cream making and refrigerating machinery, also one 20 ton compressor.

**Wis., Janesville**—(Change of date)—The School Bd. will receive bids until Dec. 22 for steam heating plumbing, etc., for high school now under construction. Van Ryn & DeGelleke, 114 Grand Ave., Milwaukee, Archts. Noted Dec. 6.

**Wis., Madison**—The University of Wisconsin, Bd. of Regents, M. E. McCaffrey, Secy., will receive bids until Jan. 17 for a 6 story, 150 x 250 ft. hospital including a steam heating system at the university. About $1,200,000. A. Peabody, Capitol Bldg,. Archt. Noted Nov. 29.

**Wis., Madison**—The University of Wisconsin Memorial Assn., c/o S. H. Goodnight, is having plans prepared for a 2 story, 2 x 8 x 336 ft. union bldg. on Langdon St. About $1,000,000. A. Peabody, 2114 Chadbourne Ave., Archt.

**Wis., Marshfield**—The city, G. J. Leonhard, Clk., plans to install additional tube boilers 350 and 500 hp. capacity in pumping station. About $50,000. Private plans.

**Wis., Oconto Falls**—The Union Mfg. Co., manufacturers of paper products, is in the market for special machinery for hydro-electric power plant to increase current from 1,500 to 2,500 hp., to furnish city with power and light.

**Wis., Rosholt**—The Rosholt Electric Light Co., c/o E. Samson, is in the market for machinery and equipment for new power plant to obtain power from water with auxiliary steam power.

**Ia., Dubuque**—The city plans to vote $250,000 bonds for water works improvements including additional wells, pumping equipment, etc. D. H. Maury, 1439 West Jackson Blvd., Chicago, Ill., Engr.

**Minn., Duluth**—The Duluth Central Htg. Co., recently incorporated with $1,500,000 capital, plans to install a central heating plant to extend from Aerial Bridge on South Lake Ave. to 4th St. between 7th Ave. W. and 3rd Ave. E., to include about 500,000 ft. steam pipe. J. J. Sawyer, Jr., Room 512, Sellwood Bldg., Engr.

**Minn., Duluth**—The St. Lukes Hospital Assn., 901 East 1st St., is having plans prepared for a 6 story, 140 x 400 ft. hospital including a steam heating system on 1st St. and 9th Ave. E. About $750,000. Schmidt, Garden & Martin, and German & Jenssen, 411 Exchange Bldg., Assd. Archts. Noted Nov. 15.

**Kan., Independence**—The Bd. Educ. is having plans prepared for a 3 story, 150 x 200 ft. junior high school including a steam heating system. About $600,000. N. S. Spencer & Son, 39 West Van Buren St., Chicago, Ill., Archts.

**Neb., Lincoln**—The Bd. Educ. will receive bids about Jan. 1st, for a 3 story, 169 x 261 ft. school. About $750,000. Fiske & Maginnis, Bankers Life Bldg., Archts. Noted. Aug. 23.

**Neb., Scottsburg**—The Bd. Educ. is having plans prepared for a high school. About $500,000. R. A. Bradley & Co., Hastings, Archts.

**S. D., Brookings**—The State Bd. of Regents, c/o T. W. Dwight, Pierre, will receive bids until Dec. 15 for 41 x 41 ft. power plant, tunnel and stock equipment, for the State College of Agriculture. About $30,000. M. F. Berg, Pierre, Engr.

**Mo., Bagnall** — The Osage Power Co., Lamar, plans a power development at Osage River, to include one 40,000 hp. and 2 small auxiliary plants, 7,000 ft. tunnel, 3 dams, transmission lines, etc. Main plant to be at tunnel, near here. About $3,000,000. R. Williams, Lamar, Consit. Engr.

**Mo., St. Louis**—C. H. Thimmig, 1662 South Jefferson Ave., is having plans prepared for a 12 story theatre and office bldg. including steam heating system on Grand and Washington Sts. About $1,500,000. P. J. Bradshaw, International Life Bldg., Archt.

**Mo., St. Louis**—The Orpheum Circuit Consolidated, Palace Theatre Bldg., New York City, is having plans prepared for a 2 story, 140 x 190 ft. theatre (Mississippi), here. M. Beck, Pres. C. E. and G. L. Rapp, 190 North State St., Chicago, Ill., Archts.

**Tex., Dallas** — Barglebaugh & Whitson, Archts., S. W. Life Bldg., will receive bids until Dec. 15 for an 18 story, 112 x 112 ft. office bldg. on Pacific and Master Sts. for the Schneider Estate. About $1,000,000.

**Tex., Edna**—The Edna Light, Ice & Water Co., Inc., is receiving bids for changing over from 220 D.C. to 2,300, 60 cycle, 3 phase and increasing ice making capacity, also for 120 hp. Diesel engine. About $25,000.

**Okla., Oklahoma City**—Oklahoma County, c/o E. S. Butterfield, Chn., plans to build a 4 story hospital including a steam heating system. About $2,000,000. Architect not selected.

**Wash., Seattle**—R. C. Semple, New York Blk., is preparing plans for a 120 x 120 ft. office building. About $1,500,000. Owner's name withheld.

**Wash., Tacoma**—The Port of Tacoma will receive bids about Feb., 1922, for equipment for Port Comn. docks, including four 3 to 5 ton steel cranes, one 2 ton electric monorail hoist, 220 volt, D.C.; miscellaneous conveyor equipment and stacking machines and about $4,000 ft. of Monorail trackage. G. W. Osgood, 612 Tacoma Bldg., Engrs.

**Cal., Long Beach**—A. H. Hubbard, 1220 East Ocean Blvd., is having plans prepared for a 7 story, 50 x 150 ft. hotel including a steam heating system on Cedar St. and B'way. About $400,000. J. and D. B. Parkinson, 420 Title Insurance Bldg., Los Angeles, Archts.

**Cal., Long Beach**—The Long Beach Bath House & Amusement Co., is having plans prepared for a 6 story office and theatre bldg. on Ocean Blvd. About $300,000. J. C. and J. H. Austin, 1st Natl. Bank Bldg., Archts.

**Cal., Long Beach**—G. W. and C. E. McIntyre, 125 East Ocean St., are having plans prepared for a 12 story, 65 x 85 ft. hotel including steam heating and refrigerating systems on Ocean Blvd. About $500,000. H. Lockridge, 700 Markwell Bldg., Archt.

**Cal., Los Angeles**—J. H. Adams, c/o R. D. King, Archt., 519 Van Nuys Bldg., is having plans prepared for a 10 story, 100 x 146 ft. office bldg., including a steam heating system on Olive St. near 8th St. for the South Carolina Telephone Co.

**Cal., Los Angeles**—The Bd. of Library Comrs. plans to build a library at Normal Hill Center. About $1,500,000. Architect not selected.

**Cal., Palo Alto**—Treasury Dept., J. A. Wetmore, Supervising Archt., Wash., D. C., plans to build a United States Public Health Service Hospital here. About $1,000,000.

**Cal., Petaluma** — The Bd. Educ., P. J. Blim, Secy., will receive bids until Dec. 27 for a 2 story junior high school on B'way and Fair Sts. About $250,000. B. Jones, 110 Washington St., Archt.

**Cal., San Francisco**—The city and county is having preliminary plans prepared for a 2 and 3 story school on 23rd and Valencia Sts. About $300,000. J. Reid, Jr., City Archt., City Hall. A steam heating system will be installed.

**Cal., San Leandro** — Alameda County, Oakland, is having plans prepared for a 1 story power plant and laundry to include refrigerating plant, incinerator, shops, etc., on County Infirmary grounds here. H. H. Meyers, Kohl Bldg., San Francisco, Archts.

**Ont., Fullarton**—The Township Council, R. H. Pomeroy, plans electric lighting and power distribution system. About $48,000.

**Ont., Port Credit**—The town is having plans prepared for a waterworks system including pumping plant, pumps, cast iron mains, valves and water tank, also electric driven centrifugal 3 stage pumps. About $75,000. James, Proctor & Redfern, 36 Toronto St., Toronto, Engrs.

## CONTRACTS AWARDED

**Mass., Boston**—The City Hospital, Harrison Ave., has awarded the contract for two 6 story, 40 x 43 ft. and 28 x 43 ft., and a 3 story addition to present hospital to Evatt Constr. Co., 161 Devonshire St., $486,000. Noted Nov. 15.

**N. Y., Buffalo**—The Natl. Biscuit Co., 409 West 15th St., New York City, has awarded the contract for a baking plant here to Thompson Starrett Co., 49 Wall St., New York City. About $750,000.

**N. Y., New York**—The Herald Square Press Bldg. Co., c/o Schwartz & Gross, Archts., 347 5th Ave., will build stores, office and factory building at 313-21 West 27th St. About $400,000. Work will be done by separate contracts.

**Pa., Philadelphia**—A. Sonefeld, 707 Walnut St., will build a 4 story, 105 x 250 ft. apartment on 47th and Walnut Sts. About $250,000. A steam heating vapor system will be installed. Owner will build by day labor.

**Pa., Reading**—The Bd. School Directors, c/o O. H. Heun, has awarded the contract for a 3 story, 177 x 226 ft. junior high school on 13th and Marion Sts. to M. Melody & Son, 1322 Race St., Phila., $240,000. Vapor heating plant to W. H. Taylor, 256 Hamilton St., Allentown.

**Tenn., Johnson City** — The Chamber of Commerce will buid a 10 story hotel here. About $450,000. A steam heating system will be installed. Work will be done by separate contracts. Noted April 12.

**O., Cleveland**—The Bd. Educ., East 6th St. and Rockwell Ave., has awarded the contract for a heating plant for the school on East 116th St. and Corlett Ave., to the Spohn Htg. & Ventilating Co., East 45th St., $159,462. Noted Nov. 22.

**Wis., Milwaukee** — The School Bd. has awarded the contract for heating and boilers for a boiler plant, etc., for the school on 2nd Ave., to the Industrial Htg. & Engr. Co., 143 Oneida St., $11,595. Noted Nov. 29.

**Mo., St. Louis**—The Polar Wave Ice & Fuel Co., Grand and Olive Sts., has awarded the contract for a 2 story ice plant on Gravois Ave. and Decolsey St. to Fruin & Colnon Constr. Co., Merchants Laclede Bldg. About $500,000.

**Wash., Keyport**—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for a 210 ft. radio tower at the Naval Radio Station here, to C. F. Martin, 4120 Dayton Ave., Seattle. $6,713.13. Spec. 4120. Noted Dec. 6.

**Cal., Oakland**—The Durant Motors Co. has awarded the contract for a 2 story, 800 x 800 ft. auto factory on End of East 14th St. to P. J. Walker Constr. Co., Monadnock Bldg., San Francisco. Cost plus percentage bases.

# PRICES - MATERIALS - SUPPLIES

**Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.**

## SINCE LAST MONTH

Sharp declines shown in refractories prices in the various districts. Chrome and magnesite ore prices quoted in this issue. Structural steel quoted at $2.78 as against $2.88 in New York warehouses. Steel shapes and plates quoted at $1.50, Pittsburgh mill, in large tonnages; small lots $1.60 per 100 lb. Structural and boiler rivets down 25c per 100 lb. in Chicago; slight declines in Pittsburgh.

Babbitt metal cheaper in New York and Cleveland. Linseed oil quoted in Cleveland at 77c. as compared with 80c. per gal. one month ago.

Electrical supplies show many advances; few declines.

## POWER-PLANT SUPPLIES

**HOSE—**

| | Fire | 50-Ft. Lengths |
|---|---|---|
| Underwriters' 2½-in. | | 56c. per ft. |
| Common, 2½-in. | | 50–5% |

| | Air | |
|---|---|---|
| | First Grade | Second Grade |
| ¼-in. per ft. | $0.38 | $0.22½ |

Steam—Discounts from List

First grade....40–10% Second grade...50–5% Third grade....50–10–5%

**RUBBER BELTING**—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 60–5% Best grade..... 50–10%

**LEATHER BELTING**—Present discounts from list in fair quantities (½ doz rolls):

| Light Grade | Medium Grade | Heavy Grade |
|---|---|---|
| 50–5% | 45% | 40% |

**RAWHIDE LACING** { For cut, best grade, 50–10%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 39c. Semi-tanned: cut, 50%; sides, 43c. per sq.ft.

**PACKING**—Prices per pound:

| | |
|---|---|
| Rubber and duck for low-pressure steam | $1.00 |
| Asbestos for high-pressure steam | 2.00 |
| Duck and rubber for piston packing | 1.00 |
| Flax, regular | 1.20 |
| Flax, waterproofed | 1.70 |
| Compressed asbestos sheet | 1.00 |
| Wire insertion asbestos sheet | 1.50 |
| Rubber sheet | .45 |
| Rubber sheet, wire insertion | .70 |
| Rubber sheet, duck insertion | .50 |
| Rubber sheet, cloth insertion | .30 |
| Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes | 1.25 |
| Asbestos wick, ½- and 1-lb. balls | .75 |

**PIPE AND BOILER COVERING**—Discounts are as follows:

| | | |
|---|---|---|
| 85% magnesia high presure | | 40% off |
| For low-pressure heating and return lines | 4-ply | 60% off |
| | 3-ply | 62½% off |
| | 2-ply | 64% off |

**PORTLAND CEMENT**—New York, $2.30 without bags, in cargo lots delivered on job. Bag charge of 40c. per bbl.

**STRUCTURAL STEEL**—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $2.78 per 100 lb.

**COTTON WASTE**—The following prices are in cents per pound:

| | New York Current | Cleveland | Chicago |
|---|---|---|---|
| White | 7.50@10.00 | 12.00 | 12.00 |
| Colored mixed | 5.50@ 9.00 | 9.00 | 10.00 |

**WIPING CLOTHS**—Jobbers' price per 1,000 is as follows:

| | 13½ x 13¼ | 13½ x 20½ |
|---|---|---|
| Cleveland | $55.00 | $65.00 |
| Chicago | 55.00 | 65.00 |

**LINSEED OIL**—These prices are per gallon:

| | New York | Cleveland | Chicago |
|---|---|---|---|
| Raw in barrels (5 bbl. lots) | $0.72 | $0.77 | $0.76 |

**WHITE AND RED LEAD**—Base price per pound:

| | Red | | | | White | | | |
|---|---|---|---|---|---|---|---|---|
| | Current | | 1 Year Ago | | Current | | 1 Yr. Ago | |
| | Dry | In Oil | Dry | In Oil | Dry and In Oil | | Dry and In Oil | |
| 100-lb. keg | 12.25 | 13.75 | 15.50 | 17.00 | 12.25 | | 15.50 | |
| 25- and 50-lb. keg | 12.50 | 14.00 | 15.75 | 17.25 | 12.50 | | 15.75 | |
| 12½-lb. keg | 12.75 | 14.25 | 16.00 | 17.50 | 12.75 | | 16.00 | |
| 5-lb. cans | 15.25 | 16.75 | 18.50 | 20.00 | 15.25 | | 18.50 | |
| 1-lb. cans | 17.25 | 18.75 | 20.50 | 22.00 | 17.25 | | 20.50 | |

**RIVETS**—The following quotations are allowed for fair-sized orders from warehouse:

| | New York | Cleveland | Chicago |
|---|---|---|---|
| Steel ⅜ and smaller | 50–10% | 60–10–10% | 65–5% |
| Tinned | 50–10% | 60–10–10% | 4½c. per lb. net |

Structural rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.

New York.....$3.50 Chicago.....$3.43 Pittsburgh....$2.25@2.40

Boiler rivets, same sizes:

New York.....$3.60 Chicago.....$3.53 Pittsburgh....2.35@2.50

**REFRACTORIES**—Prices in carlots:

| | | |
|---|---|---|
| Chrome brick, eastern shipping points | net ton | $48.00@50.00 |
| Chrome cement, 40@45% $Cr_2O_3$ | net ton | 25.00@30.00 |
| Magnesite brick: 9-in. straight | net ton | 55.00 |
| Magnesite brick: 9-in. arches, wedges and keys | net ton | 60.00 |
| Magnesite brick: Soaps and splits | net ton | 75.00 |
| Silica brick: Chicago district | per 1,000 | 35.00 |
| Silica brick: Birmingham, Ala. | per 1,000 | 32.00 |
| Silica brick: Mt. Union, Pa. | per 1,000 | 28.00 |
| Chrome ore, crude, 40@45% | net ton | 19@22 |
| Chrome ore crude, 45@50% | net ton | 20@22 |
| Magnesite ore, dead burn | net ton | 30@32 |
| Clay brick, 1st quality, 9 in. shapes, Pennsylvania | per 1000 | 34@37 |
| Clay brick, 1st quality, 9 in. shapes, Ohio | per 1000 | 34@36 |
| Clay brick, 1st quality, 9 in. shapes, Kentucky | per 1000 | 34@36 |

**BABBITT METAL**—Warehouse prices in cents per pound:

| | New York | Cleveland | Chicago |
|---|---|---|---|
| Best grade | 22.00 | 39.75 | 34.00 |
| Commercial | 9.50 | 13.50 | 8.00 |

**COLD FINISHED STEEL**—Warehouse prices are as follows:

| | New York | Chicago | Cleveland |
|---|---|---|---|
| Round shafting or screw stock, per 100 lb. base | $3.88 | $3.83 | $3.50 |
| Flats, square and hexagons, per 100 lb. base | 4.38 | 4.35 | 4.00 |

**BOILER SPECIALTIES**—F. o. b. New York or Jersey City, discounts on list:

| | Current |
|---|---|
| Copper ferrules | 75% |
| Boiler flanges | 55% |
| Boiler stay bolts | 60% |
| Boiler patch bolts | Net list |
| Boiler fitting-up bolts | 50% |
| Pressed steel boiler lugs | 10% |
| Pressed steel boiler hangers | 10% |

**WROUGHT PIPE**—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

| Inches | Steel Black | Galv. | Inches | Iron Black | Galv. |
|---|---|---|---|---|---|
| ¼ to 3 | 68½ | 56 | ¼ to 1¼ | 44½ | 29½ |

LAP WELD

| | | | | | |
|---|---|---|---|---|---|
| 2 | 51½ | 49 | 2 | 39½ | 25½ |
| 2½ to 6 | 65½ | 53 | 2½ to 4 | 42½ | 29½ |
| 7 to 8 | 62½ | 49 | 4½ to 6 | 42½ | 29½ |
| 9 and 12 | 61½ | 48 | 7 to 12 | 40½ | 27½ |

BUTT WELD, EXTRA STRONG, PLAIN ENDS

| | | | | | |
|---|---|---|---|---|---|
| ¼ to 1¼ | 66½ | 55 | ¼ to 1¼ | 44½ | 30½ |
| 2 to 3 | 68½ | 56 | | | |

LAP WELD, EXTRA STRONG, PLAIN ENDS

| | | | | | |
|---|---|---|---|---|---|
| 2 | 59½ | 48 | 2 | 40½ | 27½ |
| 2½ to 4 | 63½ | 52 | 2½ to 4 | 43½ | 31½ |
| 4½ to 6 | 62½ | 51 | 4½ to 6 | 42½ | 30½ |
| 7 to 8 | 58½ | 45 | 7 to 8 | 35½ | 23½ |
| 9 to 12 | 52½ | 39 | 9 to 12 | 30½ | 18½ |

**BOILER TUBES**—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

| Size | Lapweld Steel | C. C. Iron | Seamless Steel |
|---|---|---|---|
| 1 | ..... | ..... | $0.22 |
| 1¼ | ..... | ..... | .21 |
| 1½ | ..... | ..... | .1755 |
| 1¾ | $0.2134 | $0.2404 | .1936 |
| 2 | .1638 | .2069 | .1701 |
| 2¼ | .1872 | .2364 | .1944 |
| 2½ | .1950 | .2768 | .2280 |
| 2¾ | .2216 | ..... | .2584 |
| 3 | .2470 | .3505 | .2698 |
| 3¼ | .2610 | .4039 | .2925 |
| 3½ | .2784 | .4308 | .3120 |
| 4 | .3538 | .5475 | .3965 |

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1¼ in. to 2 in. diameter, 5c. per cut. 2½ in. diameter, 7c. per cut
2¾ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

# ELECTRICAL SUPPLIES

**ARMORED CABLE**—

| B. & S. Size | Two Cond. M Ft. | Three Cond. M Ft. | Two Cond. Lead M Ft. | Three Cond. Lead M Ft. |
|---|---|---|---|---|
| No. 14 solid | $ 45.00(net) | $138.00 | $164.00 | $210.00 |
| No. 12 solid | 135.00 | 170.00 | 225.00 | 265.00 |
| No. 10 solid | 185.00 | 235.00 | 275.00 | 325.00 |
| No. 8 stranded | 285.00 | 375.00 | 520.00 | 500.00 |
| No. 6 stranded | 400.00 | 500.00 | 560.00 | ..... |

From the above lists discounts are:

| | | |
|---|---|---|
| Less than coil lots | 20% | 10% |
| Coils to 1,000 ft. | 30% | 25% |
| 1,000 ft. and over | 35% | 30% |

**BATTERIES, DRY**—Regular No. 6 size red seal, Columbia, or Ever-Ready:

| | Each, Net |
|---|---|
| Less than 12 | $0.40 |
| 12 to 50 | .34 |
| 50 to 125 (bbl.) | .30½ |
| 125 (bbl.) or over | .29 |

**CONDUIT**, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f. o. b. New York, with 10-day discount of 5 per cent.

| | Conduit | | Elbows | | Couplings | |
|---|---|---|---|---|---|---|
| Size, In. | Black 2,500 to 5,000 Lbs. | Galvanized 2,500 to 5,000 Lbs. | Black 2,500 to 5,000 Lbs. | Galvanized 2,500 to 5,000 Lbs. | Black 2,500 to 5,000 Lbs. | Galvanized 2,500 to 5,000 Lbs. |
| ¼ | $49.40 | $58.95 | $10.15 | $11.07 | $4.40 | $4.75 |
| ⅜ | 63.02 | 76.37 | 13.50 | 14.65 | 6.25 | 6.70 |
| ½ | 90.06 | 109.60 | 20.17 | 21.97 | 8.14 | 8.63 |
| ¾ | 122.24 | 148.25 | 27.06 | 28.75 | 11.20 | 12.17 |
| 1 | 145.70 | 177.00 | 35.08 | 38.18 | 13.45 | 15.16 |
| 1¼ | 196.50 | 238.50 | 64.17 | 71.00 | 18.36 | 20.05 |
| 1½ | 109.80 | 377.50 | 105.00 | 115.87 | 26.75 | 28.90 |
| 2 | 405.76 | 492.70 | 280.40 | 309.05 | 40.00 | 43.80 |
| 2½ | 511.17 | 619.57 | 616.70 | 685.15 | 53.80 | 58.40 |
| 3 | 626.32 | 757.30 | 714.39 | 791.05 | 66.90 | 72.16 |
| 4 | | | | | | |

**CONDUIT NON-METALLIC, LOOM**—

| Size I. D., In. | Feet per Coil | List, Ft. |
|---|---|---|
| ⅜ | 250 | $0.05½ |
| ½ | 250 | .06 |
| ¾ | 250 | .09 |
| 1 | 200 | .12 |
| 1¼ | 200 | .15 |
| 1½ | 150 | .18 |
| 1 | 100 | .25 |
| 1¼ | 100 | .33 |
| 1½ | Odd lengths | .40 |
| 2 | Odd lengths | .55 |

1000 ft. and over.... 65%
Coils..... 55%
Less coils, 45%

**CUT-OUTS**—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

| | | | |
|---|---|---|---|
| S. P. M. L. | $0.08 | D. P. D. B. | $0.32 |
| D. P. M. L. | .15 | T. P. to D. P. S. B. | .18 |
| T. P. M. L. | .23 | T. P. S. B. | .29 |
| D. P. S. B. | .17 | T. P. D. B. | .47 |

CUT-OUTS, N. E. C. FUSE

| | 0-30 Amp. | 31-60 Amp. | 60-100 Amp. |
|---|---|---|---|
| D. P. M. L. | $0.40 | $1.08 | $1.35 |
| T. P. M. L. | .57 | 1.50 | 1.95 |
| D. P. S. B. | .51 | 1.35 | ..... |
| T. P. S. B. | .96 | 1.90 | ..... |
| D. P. D. B. | .72 | 2.45 | ..... |
| T. P. D. B. | 1.58 | 4.40 | ..... |
| T. P. to D. P. D. B. | 1.06 | 3.10 | ..... |

**FLEXIBLE CORD**—Price per 1,000 ft. in coils of 250 ft.:

| | |
|---|---|
| No. 18 cotton twisted | $13.10 |
| No. 16 cotton twisted | 16.50 |
| No. 18 cotton parallel | 15.20 |
| No. 16 cotton parallel | 18.95 |
| No. 18 cotton reinforced heavy | 21.60 |
| No. 16 cotton reinforced heavy | 26.00 |
| No. 18 cotton reinforced light | 15.00 |
| No. 16 cotton reinforced light | 22.00 |
| No. 18 cotton Canvasite cord | 15.75 |
| No. 16 cotton Canvasite cord | 18.55 |

**FUSES, ENCLOSED**—

| 250-Volt | Std. Pkg. | List | 600-Volt | Std. Pkg. | List |
|---|---|---|---|---|---|
| 3-amp. to 30-amp., | 100 | $0.25 | 3-amp. to 30-amp., | 100 | $0.40 |
| 35-amp. to 60-amp., | 100 | .035 | 35-amp. to 60-amp., | 100 | .60 |
| 65-amp. to 100-amp., | 50 | .90 | 65-amp. to 100-amp., | 50 | 1.50 |
| 110-amp. to 200-amp., | 25 | 2.00 | 110-amp. to 200-amp., | 25 | 2.50 |
| 225-amp. to 400-amp., | 25 | 3.60 | 225-amp. to 400-amp., | 25 | 5.50 |
| 425-amp. to 600-amp., | 10 | 5.50 | 450-amp. to 600-amp., | 10 | 8.00 |

Discount: Less 1-5th standard package, 50%; 1-5th to standard package, 55%; standard package, 65%.

**RENEWABLE FUSES, ENCLOSED**—

| Sizes | 250-Volt List-Price | 600-Volt List-Price | Std. Pkg. Quantity | Carton Quantity |
|---|---|---|---|---|
| 1 to 30-amp. | $0.50 ea. | $1.10 ea. | 100 | 10 |
| 35 to 60-amp. | 1.00 ea. | 1.25 ea. | 100 | 10 |
| 65 to 100-amp. | 2.00 ea. | 3.00 ea. | 50 | 5 |
| 110 to 200-amp. | 4.00 ea. | 5.00 ea. | 25 | 5 |
| 225 to 400-amp. | 7.50 ea. | 11.00 ea. | 25 | 1 |
| 450 to 600-amp. | 11.00 ea. | 16.00 ea. | 10 | 1 |
| 450 to 600-amp. | 11.00 ea. | 16.00 ea. | 10 | 1 |

**RENEWAL LINE FOR ABOVE FUSES**—

| | | | | |
|---|---|---|---|---|
| 1 to 30 | $0.30 ea. | $0.05 | 100 | 100 |
| 35 to 60 | .05 ea. | .06 | 100 | 100 |
| 65 to 100 | .10 ea. | .10 | 50 | 50 |
| 110 to 200 | .15 ea. | .15 | 25 | 50 |
| 225 to 400 | .30 ea. | .30 | 25 | 25 |
| 450 to 600 | .60 ea. | .60 | 10 | 10 |

Discount Without Contract—Fuses:
Broken carton ..... 5%
Unbroken carton but less than std. pkg. ..... 22%
Std. pkg. ..... 40%
Discount Without Contract—Renewals:
Less than std. pkg. ..... Net list
Standard package ..... 40%
Discount With Contract—Fuses:
Broken cartons ..... 10%
Unbroken cartons but less than standard package ..... 26%
Standard package ..... 42%
Discount With Contract—Renewals:
Less standard package ..... Net list
Standard package ..... 42%

**FUSE PLUGS, MICA CAP**—

| | |
|---|---|
| 0-30 ampere, standard package | $3.00 |
| 0-30 ampere, less than standard package | 3.25 |

**LAMPS**—Below are present quotations in less than standard package quantities:

| Straight-Side Bulbs Mazda B— | | | | Pear-Shaped Bulbs Mazda C— | | | |
|---|---|---|---|---|---|---|---|
| Watts | Plain | Frosted | No. in Package | Watts | Clear | Frosted | No. in Package |
| 10 | $0.40 | $0.45 | 100 | 75 | $0.75 | $0.80 | 50 |
| 15 | .40 | .45 | 100 | 100 | 1.10 | 1.20 | 24 |
| 25 | .40 | .45 | 100 | 150 | 1.55 | 1.65 | 24 |
| 40 | .40 | .45 | 100 | 200 | 2.10 | 2.25 | 24 |
| 50 | .40 | .45 | 100 | 300 | 3.15 | 3.35 | 24 |
| 60 | .45 | .50 | 100 | | | | 12 |
| | | | | 500 | 4.60 | 4.85 | 12 |
| | | | | 750 | 6.50 | 6.85 | 8 |
| | | | | 1,000 | 7.50 | 7.85 | 8 |

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

**PLUGS, ATTACHMENT**—

| | Each |
|---|---|
| Porcelain separable attachment plug | $0.19 |
| Composition 2-piece attachment plug | .26 |
| Swivel attachment plug | .12 |
| Current taps | .36 |

**RUBBER-COVERED COPPER WIRE**—Per 1000 ft. f. o. b. New York.

| No. | Solid Single Braid | Solid Double Braid | Stranded, Double Braid | Duplex |
|---|---|---|---|---|
| 14 | $ 6.40 | $ 8.25 | $10.25 | $16.20 |
| 12 | 8.90 | 11.17 | 13.40 | 24.00 |
| 10 | 12.00 | 14.30 | 16.30 | 30.00 |
| 8 | 16.15 | 18.20 | 21.40 | 39.40 |
| 6 | ..... | ..... | 32.50 | ..... |
| 4 | ..... | ..... | 43.01 | ..... |
| 2 | ..... | ..... | 64.40 | ..... |
| 1 | ..... | ..... | 85.00 | ..... |
| 0 | ..... | ..... | 101.68 | ..... |
| 00 | ..... | ..... | 123.92 | ..... |
| 000 | ..... | ..... | 147.64 | ..... |
| 0000 | ..... | ..... | 176.84 | ..... |

**SOCKETS, BRASS SHELL**—

| ½ In. or Pendant Cap | | | ⅜ In. Cap | | |
|---|---|---|---|---|---|
| Key Each | Keyless Each | Pull Each | Key Each | Keyless Each | Pull Each |
| $0.33 | $0.30 | $0.60 | $0.39 | $0.36 | $0.66 |

Less 1-5th standard package ..... 15%
1-5th to standard package ..... 30%
Standard package ..... 45%

**WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE**—

| | |
|---|---|
| No. 18 B. & S. regular spools (approx. 8 lb.) | 33c. lb. |
| No. 18 B. & S. regular 1-lb. coils | 34c. lb. |

**WIRING SUPPLIES**—

| | |
|---|---|
| Friction tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots | 33c. lb. |
| Rubber tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots | 33c. lb. |
| Wire solder, less 100 lb. 27c. lb., 100 lb. lots | 23c. lb. |
| Soldering paste, 2 oz. cans | $1.00 doz. |

**SWITCHES, KNIFE**—

TYPE "C" NOT FUSIBLE

| Size, Amp. | Single Pole, Each | Double Pole, Each | Three Pole, Each | Four Pole, Each |
|---|---|---|---|---|
| 30 | $0.42 | $0.68 | $1.02 | $1.36 |
| 60 | .74 | 1.22 | 1.84 | 2.44 |
| 100 | 1.50 | 2.50 | 3.76 | 5.00 |
| 200 | 2.70 | 4.50 | 6.76 | 9.00 |

TYPE "C" FUSIBLE, TOP OR BOTTOM

| | | | | |
|---|---|---|---|---|
| 30 | 70 | 1.06 | 1.60 | 2.12 |
| 60 | 1.18 | 1.80 | 2.70 | 3.60 |
| 100 | 2.38 | 3.66 | 5.30 | 7.30 |
| 200 | 4.40 | 6.76 | 10.14 | 13.50 |

Discounts:
Less than $10.00 list value ..... +5%
$10 to $25 list value ..... 10%
$25 to $50 list value ..... 15%
$50 to $200 list value ..... 25%
$200 list value or over ..... 30%